

Native Grass Forages for the Eastern U.S.



SECTION THREE

Managing Native Grasses

Native grass management is basically the same as managing any other forage grass. Of course, there are some differences, but all of the same principles apply. Relative to cool-season perennials, there are differences associated with timing of management practices. Most other differences are based on the taller growth habit of the natives relative to the shorter grasses (cool- or warm-season) we commonly manage in the eastern U.S. The following chapters address these principles as well as the practical aspects of grazing management, hay production, fertility management and weed control in native grasses. The economics of forage production with native grasses are also included in this section.

NATIVE GRASS FORAGES FOR THE EASTERN U.S.

CHAPTER TEN

Grazing Management

with Ray Smith

The basics of native grass biology provide the best context for understanding grazing management for these species. Therefore, before delving into more specific recommendations and guidance on grazing itself, some basic principles are addressed below. This includes principles important to management of *any* forage grass: energy balances, growing points, leaf surface area, rest, plant maturity and growth curves.

BASIC PRINCIPLES OF GRASS MANAGEMENT

Natives, like all other grasses, produce energy which is used for metabolism and growth or is stored for use during dormancy and to initiate growth the following spring. Ensuring that the amount of energy removed from the plant through grazing does not place the plant into a negative energy balance is fundamental to maintaining a high level of plant vigor. Plants with high amounts of leaf surface area also have well developed root systems — and vice versa. Thus, severe defoliation has a negative effect on root mass and reduces the plant's energy reserves — as well as reducing its ability to replenish those reserves (Figure 10.1). **So the first and most fundamental rule for managing native grasses is the same as for any forage species: don't beat them into the ground! Put another way, "it takes grass to grow grass!"**

The way that a given grass species stores energy is important to understanding the optimum grazing management for that species. Take, for example, switchgrass and bermudagrass. Both species store a considerable amount of energy in above ground structures (stems,

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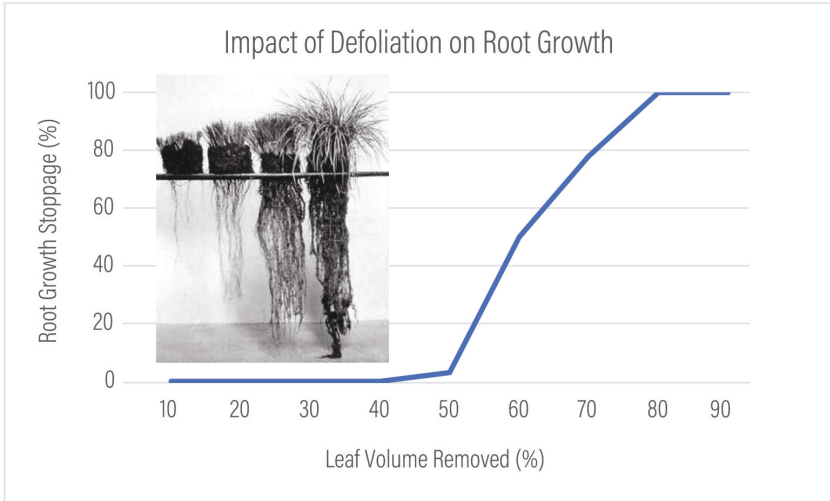


Figure 10.1. A study conducted in the 1950s documented the impact of defoliation on root vigor. Once leaf volume removed was above 50 percent, the impact to the roots was dramatic. Over time, prolonged heavy grazing will dramatically reduce root volume to as little as 5 percent of that of a rested plant (inset). Crider, 1955. USDA.

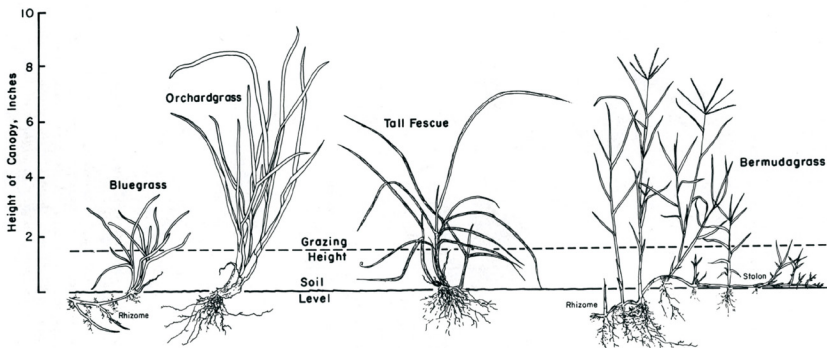


Figure 10.2. Compared to many introduced forages, especially bluegrasses and bermudagrass, native grasses store much of their energy within stems that are well above ground and, as such, are much more vulnerable to excessive grazing pressure. Although native grasses are not depicted here, the difference between orchardgrass on the one hand and bermudagrass and bluegrass on the other illustrates the principle. Source: Blaser et al., 1986. Forage-animal management systems. Virginia Tech Extension Bulletin 86-7.

leaves, reproductive organs). However, in the case of bermudagrass, many of these structures grow close to the ground and are, therefore, less impacted by grazing animals (Figure 10.2). For switchgrass, on the other hand, these same structures occur well above the soil surface and, as a consequence, can be impacted more readily by grazing. Thus, like any tall-growing species, switchgrass energy reserves are more easily depleted when plants are grazed to low residual heights.

This was well illustrated by a North Carolina study that compared lowland switchgrass grazed to one of three target heights, 4-6, 8-10 and 14-16 inches¹⁶. By the end of the third year, the study was suspended because the stands maintained at the lowest height became too weak for the project to continue. The authors of the study concluded that canopies below 12 inches weakened the switchgrass leading to unacceptable stand thinning. This pattern is not restricted to switchgrass. In another study in North Carolina, eastern gamagrass was grazed over four years to one of three target heights, 10, 15 and 21 inches¹⁵. Guess what happened. The stands with the shortest height were degraded by the third year of the study and could no longer be used. The conclusion was that stand heights must be above 15 inches to maintain long-term stand vigor.

A second issue with tall species is the position of their growing points. Growing points, also known as apical meristems, are the structures from which new stems and leaves arise (Figure 10.3). Again, using the example of switchgrass and bermudagrass, the latter has growing points very near the soil surface. For switchgrass though, growing points are elevated several inches above the ground and are thus vulnerable during grazing or hay harvest. If removed, the plant must replace the growing point before any further production of foliage can resume. And the energy required to produce the new growing point cannot be produced by leaves that are no longer present. Rather, that energy must be drawn from root reserves. So, the second key point we learn based on plant biology is that **tall grasses must be managed at taller heights than those that grow close to the ground.**

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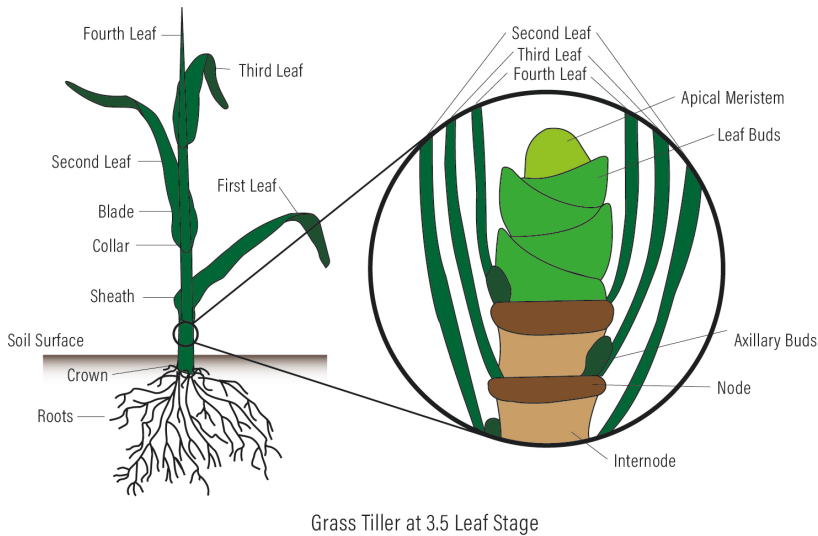


Figure 10.3. Schematic drawing of an apical meristem, also known as growing points. In native grasses, these structures become elevated above the ground surface as the season goes on. In switchgrass, for instance, the growing points may be 8 inches or more above the soil surface by early summer. Source, L. Manske, North Dakota State University; <https://www.ag.ndsu.edu/archive/dickins/research/2003/range03a.htm>.

A study conducted in Nebraska illustrates this problem quite well. Energy reserves were compared between switchgrass plants that had their growing points removed by clipping and those that were clipped but with their growing points left intact. Those with removed growing points demonstrated a substantial reduction in root reserves compared to those with intact growing points (Figure 10.4). Although the plants that had their growing points removed recovered in about five weeks, above ground growth during this period was limited. Therefore, any regrowth of the pasture would be delayed and weed encroachment would be far more likely.

Finally, as is true for all other forage grasses, plant maturity has a strong impact on forage quality for native grasses. The process is similar. As plants mature, leaves age and become more fibrous and have lower digestible energy. At the same time, leaf-to-stem ratios decline

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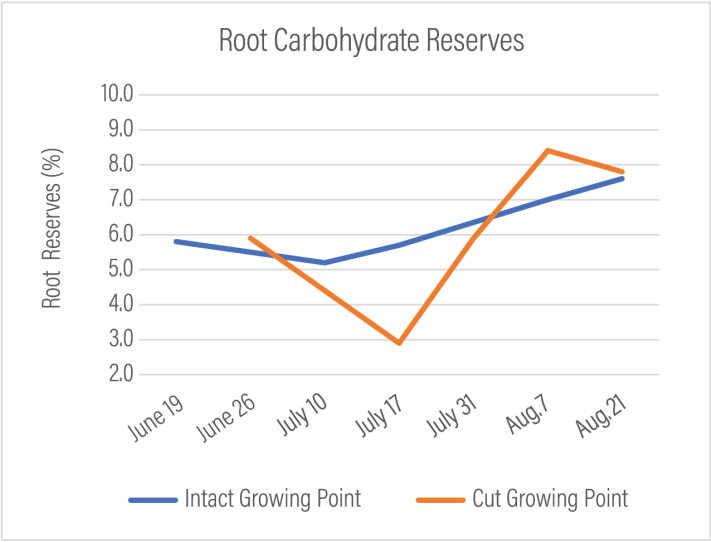


Figure 10.4. Switchgrass plants that had their growing points removed experienced a substantial drop in root carbohydrate reserves compared to those with intact growing points. Adapted from Anderson et al., 1989. *Agronomy Journal* 81:13-16.

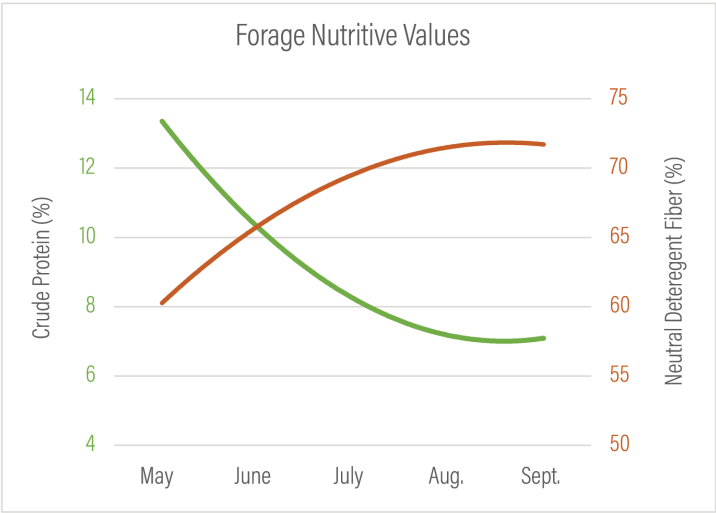


Figure 10.5. Trends in CP (green line) and NDF (red line) over the course of the summer grazing season as plants mature. Lines are averaged across four studies of three years each. Source: Aiken, 1997. *Journal of Animal Science* 75:803-808; Backus et al., 2017. *Journal of Animal Science*. 95:3143-3153; Brazil et al., 2020. *Agronomy Journal* 112:5067-5080; and Keyser et al, 2020. *Agronomy Journal* 112:1-11.

(less leaf, more stem) and stems, of course, have far lower nutritive value than leaves. Thus, as the season progresses and plants mature, forage quality decreases^{7; 22}. In an eastern gamagrass grazing study conducted during the 1990s in Arkansas, crude protein (CP) declined as the season progressed. In May, CP in the young, vegetative plants was about 12 percent (Figure 10.5). By mid-July, CP had declined to 6-7 percent where it remained for the balance of the summer grazing season¹. In another study, this one focused on a big bluestem/little bluestem/indiangrass blend, the pattern was nearly identical. At the start of the season CP was just below 15 percent but dropped as summer progressed to about 9 percent and then, in July and August, remained at about 8 percent¹¹. Fiber levels in these same grasses trend in the opposite direction, increasing as summer continues (Figure 10.5). **The third key point plant biology teaches us about managing native grasses is not to let them get too mature.**

Growth curves

Understanding growth curves is also important in grazing management of native grass forages. Two grazing studies conducted at the University of Tennessee used a research protocol known as “put-and-take stocking.” With put-and-take stocking, weekly adjustments are made to stocking density (pounds per acre) for each experimental pasture. The goal is to adjust stocking density as needed to maintain the grass canopy within a target height range throughout the grazing season. As the rate of grass growth first increased in early summer and then decreased later in the season, stocking density was increased and then decreased accordingly to match the rate of growth of the forage. Data from these studies was used to derive growth curves for lowland switchgrass, a big bluestem/indiangrass blend and eastern gamagrass.

Based on these curves, there are several important takeaway lessons. First, lowland switchgrass can carry a greater stocking density than the other native grasses (Figure 10.6). Secondly, switchgrass has a notably peaked growth curve reaching a maximum during mid-June and showing

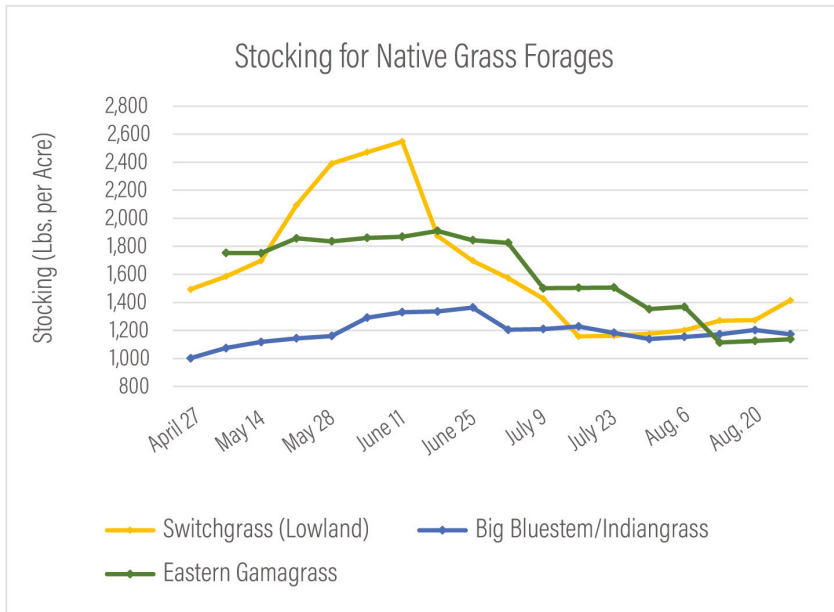


Figure 10.6. Weekly stocking (pounds per acre of live animal) for three native grass forages during grazing trials in Tennessee. A stocking approach known as “put-and-take-stocking” was used to maintain consistent canopies throughout the summer. The result illustrates the growth rates of the grasses during the course of the season. Eastern gamagrass grazing occurred with no supplemental N inputs, the other two species received 60 lbs. of N each April throughout the study. University of Tennessee, unpublished data.

a significant decline during late summer. For eastern gamagrass, stocking density is lower than with switchgrass, at about 1,600-1,800 pounds per acre, for much of the summer. However, it is worth noting that the study from which the growth curve for eastern gamagrass was derived was conducted without the addition of any supplemental N. Therefore, the carrying capacity may have been underestimated relative to the other two forages, which had 60 units per acre N applied annually. For the big bluestem/indiangrass blend, stocking density is the lowest of the three forages at approximately 1,200 pounds per acre for much of the summer grazing period.

There are two other facts that become apparent in examining these growth curves. First, the peaked curve exhibited by switchgrass is much less apparent with the other two forages. Secondly, all three forages

show a response to daylength with a peak in production in mid-summer at about the time of the summer solstice. That change at mid-summer is most pronounced with switchgrass. Other researchers have confirmed that switchgrass growth is strongly daylength-dependent. For all these species, there is a shift from vegetative growth early in the summer towards reproductive growth by mid-summer. Therefore, **it is important to manage grazing pressure to keep the plants from developing reproductive structures. If they remain vegetative, forage quality will remain greater.**

Based on the combination of lowland switchgrass's peaked growth curve and strong daylength-driven development, it is critical to graze it very aggressively early in the season. Everyone I have ever known that grazed switchgrass for the first time got way behind the forage their first year. Be prepared to stock heavily, as much as 3,000 pounds per acre when you first go on in the spring. By contrast, stocking on big bluestem or the big bluestem/indiangrass blend more closely resembles rates typical of peak spring growth of cool-season perennials. Thus, the management may seem more familiar to most graziers.

WHEN TO INITIATE GRAZING IN SPRING

Native grasses break dormancy in the Mid-South in late March but do not begin to grow appreciably until late April. In a typical spring, eastern gamagrass will be ready to graze in late April, switchgrass in late April to early May, big bluestem by early May and indiangrass and little bluestem in early to mid-May (Figure 10.7). Although these dates will shift by a few weeks with latitude, the relationship among the grasses will remain consistent.

Regardless of species, it is important to delay stocking your pasture until there is enough growth of new vegetation to ensure that the plants can sustain grazing. If grazing begins too soon, the energy needed to replace leaves consumed by cattle will be drawn from root reserves rather than from active photosynthesis; you will be grazing the plants' roots! Intensive studies of root energy reserves of native grass have



Figure 10.7. A vigorous stand of eastern gamagrass in mid-April. Ample leaf surface area is present and canopy heights are above 16 inches. Under rotational grazing, the first turnout could be delayed several weeks to accumulate additional forage. Continuous grazing could begin at this stage of growth. An earlier start would be premature and would result in weakened plants.

shown that these plants reach a low point in their annual cycle during spring after initial shoot emergence and growth. At this point, root energy reserves are at about 25-30 percent of what they are at their peak^{41; 51}. It is not until sufficient leaf surface area has developed to allow for adequate photosynthesis that the plants begin to replenish their depleted energy reserves. Therefore, grazing too soon stresses plants that have already spent much of their energy reserves and have less ability to respond. Rather, grazing should not begin until there is enough leaf area to provide forage as well as to support photosynthesis at a level that allows for continued plant growth and replacement of forage consumed by grazing animals. **A good rule of thumb for initiating grazing in native grasses is to wait until average canopy height of the stand has reached at least 13-15 inches.**

On the other end of the spectrum, it is important not to wait too long to start grazing native grasses. Rapid late spring growth can quickly result in overmature swards with reduced forage quality. In such cases, forage intake

will be reduced, trampling losses will increase and animal performance will suffer. As mentioned above regarding switchgrass, spring growth can be very rapid requiring heavy stocking densities to keep the grass vegetative. Several studies have shown that once this grass gets to a point where stem elongation is occurring, it can be quite difficult to catch back up. A study conducted in Nebraska provides a great example of this problem³. In the first year of that study, stocking was both late and light. As a result, animal performance and gains were poor (Table 10.1). The following year, with much more aggressive stocking, the switchgrass was maintained in a vegetative state and animal performance and pasture productivity both increased markedly.

Table 10.1. There is a large penalty when grazing grasses that have become overmature. In this Nebraska study, improved grazing management in 1983 resulted in a much more vegetative sward. The improved forage quality led to higher rates of gain and, on average, more than doubling of gain per acre. Adapted from Anderson et al., 1988. Journal of Animal Science 66:2239-2244.

Cultivar	1982		1983		Net Improvement	
	ADG (lbs. per day)	Gain per acre (lbs.)	ADG (lbs. per day)	Gain per acre (lbs.)	ADG (lbs. per day)	Gain per acre (lbs.)
Trailblazer	0.99	209	2.16	406	1.17	197
Pathfinder	0.59	127	1.76	331	1.17	204

IMPROVED SUMMER GRAZING STARTS IN THE SPRING

A common mistake graziers make is to wait until their cool-season forages are becoming senescent and productivity has fallen off before switching from cool- to warm-season grasses. There are several published studies where this late switch to warm-season grasses has taken place. The result is always the same — the warm-season grasses are overmature, forage quality is poor and animal performance suffers (Figure 10.8). In one such study, animals were first moved onto the native grasses during July. At that point, forage mass was 5-6 times greater on the warm-compared to the adjacent cool-season grasses and, not surprisingly, CP of the warm-season grasses had dropped to about seven percent and neutral detergent fiber (NDF) was above 80 percent⁶⁴! Such pastures



Figure 10.8. Lowland switchgrass pasture on June 23. These steers are finding plenty to eat, but the stand has gotten tall and stemmy and will soon develop seedheads. Consequently, forage quality is declining and animal performance as well as pasture beef production will suffer. Heavier grazing pressure is needed to keep the stand in a more vegetative state and ensure high quality forage remains available well into the summer.

provide little benefit. The far better choice is to switch to the warm-season pastures as soon as they are able to sustain grazing.

Another benefit to timely grazing in the early part of the season is that you can improve the timing and quality of the forage produced for the balance of the summer. In a study of spring grazing of switchgrass in Iowa²⁵, an aggressive early June hay harvest when the switchgrass was about 24 inches tall resulted in approximately 80 percent of the year's forage being produced in July and August. Normally, much of the yield of switchgrass will be produced in May and June. This early defoliation produced high-quality hay and the quality of the later-produced forage was not compromised. A similar study tested spring harvests on big bluestem and had results similar to the Iowa trial with improved mid- to late-summer forage production⁴⁶.

Timing for such a treatment in the Mid-South would be about three, perhaps four weeks earlier, but the principle is the same: conduct the early harvest before stem elongation, while the grass is still vegetative

But ... I've heard you can graze native grasses down to 8 inches?

Some recommendations state that grazing heights for native grasses can or should be as low as 8 inches. Such recommendations are based on studies that show big bluestem, for example, has the biological ability to tolerate this closer grazing. However, in parts of the country with greater precipitation and longer growing seasons (i.e., the Mid-South and Deep South) there is more competition from introduced grasses and weeds. In these regions, closer grazing and the resulting increase in sunlight reaching the ground leads to increases in these weeds (Figure 10.10). A study in North Carolina documented a substantial increase in weed occurrence as canopy height of native grasses decreased from 21 inches (one percent weed occurrence) to 15 inches (36 percent) and to 10 inches (64 percent). In many cases, the weeds will be either perennials or prolific reseeding annuals. Examples for the first category include common bermudagrass and horsenettle, and for the second, goosegrass and pigweeds. In either case, the problem will not go away quickly and may be



Figure 10.10. In the Southeast, short canopy heights create opportunities for undesirable species, such as the common bermudagrass pictured here, to gain a foothold within native grass pastures. Taller canopies that keep the ground shaded allow the native grasses to fully occupy the site.

costly to correct. In more northern areas, such as Iowa or Pennsylvania, pressure from warm-season weeds is not as severe. However, in those areas encroaching cool-season weeds can also become a more serious problem with these shorter grazing heights. Furthermore, the shorter the residual height, the greater the rest period required before regrowth can occur. Studies that have grazed canopies to 8 inches or below typically recommend a rest period of 42 days for full recovery. Such a long period reduces flexibility in management of the pasture. Taken together, it is certainly true that you can graze native grasses to lower heights than recommended here, but such lower heights can come at an unacceptably high cost.

but do not remove the growing point. Waiting until plants have become stemmy or are producing seedheads penalizes you in many ways. And while both the above-mentioned studies focused on hay cutting for the early harvest, grazing with similar timing and severity will accomplish the same goal (Figure 10.9). If a rest period is needed following the early graze, no matter, simply go back to the cool-season grass until the warm-season pasture is once again ready to graze.



Figure 10.9. Heavy grazing of this switchgrass pasture for four weeks starting in early May followed by 17 days of rest left the stand in a vigorous and vegetative condition leading into mid-summer. The photo was taken on June 23, the same date as the image in Figure 10.8.

GRAZING STRATEGIES

For native grasses, about **any grazing strategy you can think of will work so long as you respect the sideboards already mentioned — do not beat them into the ground, allow for greater residual heights, keep them vegetative and understand their growth curves.** A simple way to build these sideboards into your management is to use canopy height as a guide. While not a perfect tool for native grass management, canopy height can nevertheless be quite useful. So, using height as a guide, here is a simple rule: **keep the canopy between the top of your boot and your hip throughout the growing season** and you will maintain good forage quality and a productive, vigorous stand. Simple enough. But let's unpack that a bit.

As previously explained, it is critical that you recognize and respect minimum canopy height targets for tall-growing native grasses. They should be kept above about 14 inches tall — the “top of your boot” end of the rule. This will vary somewhat by species and even by cultivar. For example, lowland switchgrass and lowland eastern gamagrass will both do better at greater residual heights while big and little bluestem can tolerate closer grazing (Table 10.2). And given the previously described problems associated with overmature native grasses, grazing management should be such that seedheads never, or at least rarely, develop. This will require keeping plants vegetative, an outcome that will keep these tall species at heights no greater than about 30-32 inches — your hip.

Table 10.2. Recommended canopy height in inches for managing native grass pastures under either rotational or continuous stocking.

Species	Grazing Approach	
	Rotational	Continuous
Switchgrass		
lowland types	15-30	18-24
upland types	12-26	14-18
Big bluestem/indiangrass	13-26	14-18
Eastern gamagrass	16-32	18-22

As an example, with rotational grazing, livestock should be introduced before the grass gets past hip height and removal of animals should occur before grass height drops below the top of your boot. Based on the targets presented in Table 10.2, the old adage “take half and leave half” comes readily to mind. With continuous grazing, the minimum canopy height targets will require a modest adjustment upward (Table 10.2). This is because keeping shorter canopies for extended periods will result in reduced overall leaf surface area and, therefore, reduced energy production. The bottom line is that almost any grazing strategy will work so long as you respect the canopy, keeping it within a range that permits adequate energy production while keeping the plants vegetative.

Rotational grazing

Perhaps the best and most often recommended approach for managing native grasses is some form of rotational grazing. It naturally lends itself to tall species and their specific height requirements. Rotational grazing is also flexible. If on a particular entry you grazed the sward down below the target height, you can simply allow a longer rest period before coming back on. Conversely, if the stand is getting too tall, you can remain on it a few days longer to catch back up.

Another advantage of rotational grazing is that you can, with appropriate stocking, avoid cattle having excessive selectivity in their grazing. This is important because with fast-growing species like the native grasses, some plants that do not get grazed initially will become stemmy and be avoided by cattle as the season progresses. In such situations, portions of the pasture will become overgrazed while others go to seed. With eastern gamagrass, the potential for uneven grazing in understocked pastures may be greater due to the growth habit of this species (Figure 10.11). If this pattern continues, weeds will become established, and the competition from those weeds will further weaken the stand, all creating a downward spiral. Rotational grazing with proper stocking levels can avoid these problems and allow for uniform grazing that maintains all plants in a vigorous condition.



Figure 10.11. Because of the wide spacing and open condition of most eastern gamagrass stands, irregular grazing among individual plants can become an issue. Note the large robust plant at top right. It has a large number of tillers, plenty of height and ample leaf surface area. To its left (top left) is a plant that has received greater grazing pressure and as a result is short, has fewer tillers, and less leaf surface area. Finally, in the lower left of the image is a very small plant with few tillers and limited leaf surface area. It has been repeatedly overgrazed and, without rest, is likely to die within a season or two. With shorter and heavier stocking intervals that apply more uniform grazing pressure this situation can be easily avoided.

Arriving at the proper stocking density will take some trial and error but, based on the growth curves in Figure 10.6, a good starting point for the big bluestem/indiangrass blend is about 1,000 pounds per acre. Keep in mind that cattle will gain considerable weight through the grazing season leading to a greater stocking density as the season progresses. For eastern gamagrass, 1,600 pounds of live animal per acre may be needed. For lowland switchgrass, especially in spring when growth is most rapid (May in the Mid-South), stocking density will need to be approximately 2,500 pounds per acre. Stocking density for upland switchgrass cultivars will be closer to the level for the big bluestem/indiangrass blend. On poorer sites, stocking density will have to be reduced. For example, during a study conducted on a reclaimed surface mine in eastern Kentucky where soils were extremely poor, stocking density on big bluestem/indiangrass pastures was reduced to

450 pounds per acre. Likewise, on better ground, pastures with excellent stands or those receiving greater fertilizer amendments may all need greater stocking (Table 10.3).

Table 10.3. Stocking of native grass pastures based on several studies in the eastern U.S. Per acre stocking is provided for steer days per acre because most of these studies evaluated steers as the model animal.

Forage	Grazing days per acre			Source
	Steers	AUD	N per acre	
Eastern gamagrass	358	215	210	Burns and Fisher, 2010.
Big bluestem	283	170	307	Burns and Fisher, 2013.
Eastern gamagrass	355	213		
Switchgrass	378	227		
Big bluestem/ indiangrass	154	92	60	Backus et al., 2017.
Eastern gamagrass	245	147		
Switchgrass	235	141		
Big bluestem/ indiangrass	152	91	0	Brazil et al., 2020.
Eastern gamagrass	236	142	0	Keyser et al., 2020.

A rotational grazing system for native grasses could involve as few as three paddocks or as many as you want. Regardless of the number of paddocks in a system, movement among these units should be based on grass height as described above and **not on a fixed number of days or weeks** (Figure 10.12). The amount of rest needed between entries will vary based on how close your defoliation is but may require as much as 42 days where grazing is close, below 8 inches. Using the heights indicated in Table 10.2, spring grazing could involve as little as two weeks of rest.

The disadvantage of rotational grazing is that it can require more time for management. And while forage utilization may be more uniform,



Figure 10.12. A rotationally grazed native grass pasture showing a unit that was just destocked (right) with a 12-inch residual canopy and a unit (left) with about two weeks rest. Cattle were on a third paddock at the time this picture was taken. Properly managed, rotational grazing is a very good way to manage native grass pastures.

animal performance may decline. This is because animal selectivity is reduced, cattle must eat what is in front of them rather than being able to pick and choose over an extended number of days on the pasture. Studies in Oklahoma and North Carolina have shown reductions in ADG of 10-20 percent^{39; 15} with rotational versus continuous stocking. On the other hand, total beef production per acre may not be much different because of greater stocking rates possible with rotational grazing due to improved forage utilization. Thus, the penalty may be largely in the form of rates of gain, something more important for growing classes of animals.

Continuous grazing

For years, I have heard folks say that continuous grazing is not an option with native grasses, that it is a good way to get rid of a perfectly good stand. The reasoning being that with continuous grazing the grasses receive no rest, energy reserves are depleted, plants lose vigor and the downward trend accelerates as cattle continue to remove what decreasing growth the grasses are able to produce. Eventually, they will become too weak to persist and the stand will be lost. Certainly, unregulated

continuous grazing will result in loss of native grasses. But can appropriately timed and managed continuous grazing work?

A few years ago, we initiated a study to test that notion. We compared two continuous grazing strategies for big bluestem/indiangrass/little bluestem pastures. One strategy used an initial stocking density based on the growth curve in Figure 10.6 with no adjustments, the number of head remained consistent all summer long. The second strategy started with a stocking density 25 percent greater than that of the first strategy but included a single, late June adjustment, reducing stocking density to 75 percent of that of the first strategy (Figure 10.13). This modified approach, referred to as 'Heavy Early', was intended to more closely match the growth curve of these grasses but still minimize producer time required for managing grazing.

What did we learn? That even under continuous grazing, by maintaining reasonable canopies, 14-18 inches tall for much of the summer, the grass was not weakened even after three consecutive summers of continuous grazing (Figure 10.14). In addition to maintaining appropriate canopy heights, the grasses were allowed to develop to 14-15 inches in height each spring prior to stocking and, in the fall, stands were given six weeks rest before frost. Pasture productivity as measured by pounds of beef produced per acre, grazing days per acre and animal performance did not differ between our two strategies and were comparable to those from studies that relied on other grazing strategies. The study from the 1950s presented in Figure 10.1 illustrates why this approach can be sustained. With only partial defoliation, there is little to no impact on root development. This also explains why properly stocked range in the Great Plains can be grazed all summer without degrading the pasture.

The take-home message here is that you should not hesitate to graze a native grass pasture continuously if that meets other goals you have for your operation. Just be sure to respect the grasses' need for an adequate canopy as well as energy demands during spring emergence and leading into fall dormancy. This study teaches us another lesson though, and that is that native grasses, given these same sideboards, are really not

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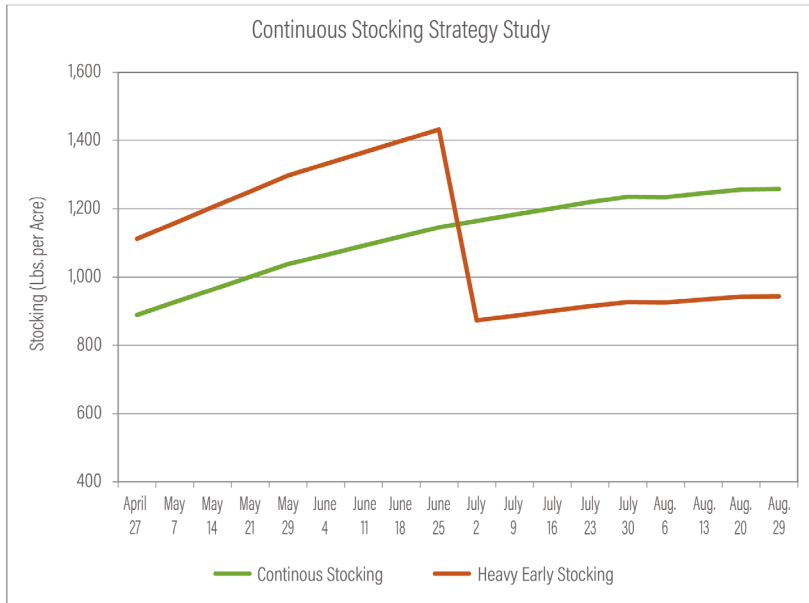


Figure 10.13. Chart illustrating stocking levels for two, season-long grazing approaches for native grasses. Under the continuous approach, animals are stocked at the start of the season and no adjustments are made. For Heavy Early stocking, an adjustment is made once during summer in late June to accommodate the slowing rate of growth of the native grass. In this example, stocking is initially 25 percent greater than that for continuous and then reduced to 75 percent of that level in late June.



Figure 10.14. A pasture grazed under the continuous strategy (a) and an adjacent one grazed under the Heavy Early strategy (b). Both pictures taken on August 18, the 99th day of continuous grazing that summer. It is worth noting that the site had been under drought that summer since late May.

difficult to manage. All we did in this study was stock in early May and come back to get the cattle 15 weeks later at the end of August. For the Heavy Early treatment, we came back at the end of June and removed some animals. In either case, this is minimal grazing management!

Patch-burn grazing

A relatively new approach to grazing management, one developed in the southern Great Plains recently, is patch-burn grazing. What is patch-burn grazing (PBG)? Also known as “pyric herbivory,” PBG is really a very old idea, one that attempts to mimic the natural processes that have shaped North American grasslands for eons. Here’s how it works. Each spring, a subsection or “patch” of the pasture is burned on a rotating basis so that over several years, the entire pasture has been burned (see Chapter 17 for more on use of fire in managing native grasses). In the southern Great Plains, having four or five patches of a pasture burned over as many years makes sense. However, where precipitation is greater, having three patches within a pasture is preferable. What makes this system work is that the patch that has been burned most recently, during the current spring, has the highest quality forage and cattle naturally focus most of their grazing within this area.

As each new burn takes place in subsequent springs, the focus of cattle grazing pressure shifts to the most recently burned patch (Figure 10.15). The longer the interval since a given patch has been burned, the less cattle will graze it. The current year’s burned patch will be grazed quite heavily, in one Oklahoma study, as much as 75 percent of the grazing time²⁴. The following summer, one year post-burning, the grazing on that patch is cut by about half and the second year post-burning, by about one-half again. Therefore, over a 3-year period, each patch will get ample rest despite very heavy grazing pressure the year of the burn. Over the full burning cycle then, PBG effectively distributes grazing pressure across the entire pasture. This method is similar to rotational grazing but without any additional fencing or water sources. It should be noted that the degree of selectivity among patches is regulated by two factors, stocking

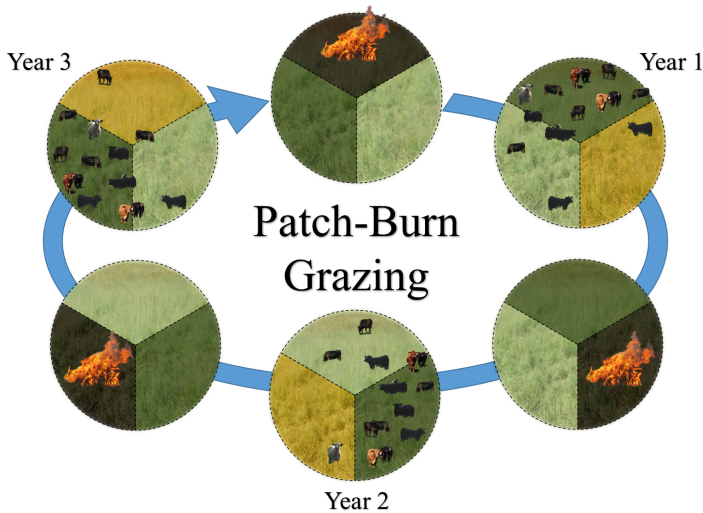


Figure 10.15. Patch-burn grazing schematic showing a typical 3-year cycle for this management tool. Starting at the top center and moving clockwise, each annual fire shifts grazing pressure to the most recently burned patch. Patches receive increasing amounts of rest as the time since burning increases. Credit, A. Vander Yacht.

density and timing of stocking post-burning. Lighter stocking density and quicker re-stocking post-burning both contribute to greater selectivity. On the other hand, heavier stocking density and a longer delay in stocking post-burning both contribute to reduced selectivity among patches.

Patch-burn grazing has reinforced one of the lessons we learned from the continuous grazing project — native grasses can be very resilient even under severe grazing. This is made clear by the extremely heavy grazing that occurs on the patches during the year of the burn, often leaving canopies as short as 4 inches for much of the season (Figure 10.16). In the Oklahoma study mentioned above, cover of the tall grasses (big and little bluestem and indiangrass) had completely recovered after two years and often exceeded the amount in the traditionally-managed pastures by the third year. These grasses were resilient despite the heavy grazing the year of the burn because of the rest during the two subsequent years.

Studies in the Great Plains and elsewhere have shown that animal performance and pasture productivity between PBG and traditionally

NATIVE GRASS FORAGES FOR THE EASTERN U.S.



Figure 10.16. A pasture in Kansas (a) managed under a three-year patch-burn graze cycle. To the left of the lane is the current year's burn showing very heavy utilization. To the right of the lane is the previous year's burn patch showing considerably less grazing pressure and, as a result, substantial recovery of the grasses. The current year's burn in a patch-burn grazed pasture in Missouri also shows heavy utilization (b). Despite this heavy grazing pressure, ample rest in subsequent years ensures the grasses remain vigorous



Figure 10.17. Native grass pasture managed with patch-burn grazing. Disced fireline is visible in middle of field with current year's burn on the far side of the line and the previous year's burn on the near side of the field. Note heavier grazing on more recently burned patch and thatch on previous year's burn.

-managed pastures, those grazed continuously and without fire, were similar. A recent study conducted in Kentucky and Tennessee compared PBG to rotational grazing using three patches/paddocks in both treatments. As was the case with the Oklahoma study, the more traditional management using rotational grazing and the PBG produced similar rates of gain and per acre gain (Table 10.4).

Table 10.4. Patch-burn grazing (PBG) and rotational grazing (RG) were compared on three sites in Kentucky and Tennessee. Rates of gain (ADG) and total beef produced per acre were similar between these two grazing management approaches. University of Tennessee, unpublished data.

Breed	Animal class	Initial weight (lbs.)	ADG (lbs. per day)		Total beef (lbs. per acre)	
			PBG	RG	PBG	RG
Angus X	Heifer, yearling	854	2.00	1.93	130	130
	Heifer, weaned	561	1.53	1.49	95	101
Holstein	Heifer, yearling	1,107	1.61	1.73	176	155
Jersey	Heifer, yearling	779	1.36	1.41	148	127

Clearly, PBG can be used reliably with native grass pastures in the eastern U.S. (Figure 10.17). One caution, however, is that in many range-land settings in the Great Plains where PBG has been applied, the plant community is still dominated by native species. In many parts of the eastern U.S., especially in the southern half of this region, a large number of introduced species that are not desirable in pastures are prevalent. Therefore, in the Great Plains, native forbs are able to take advantage of the reduced competition from the tall grasses in the year of the burn, whereas in the southeastern U.S., many of these undesirable species can become established during this period. Thus, the benefits of PBG for conservation may be reduced and future weed problems may increase.

Management-intensive grazing

Another approach to grazing management that has received a good deal of attention in recent years is management-intensive grazing

(MiG). This strategy, which is a form of rotational grazing, relies on extremely high stocking densities, very short duration grazing bouts and long rest intervals. There is a good deal of variation in application, but 50,000-100,000 pounds per acre and entries of just a few hours are not uncommon. The underlying premise, like that for PBG, is to simulate natural disturbance patterns. In this case, the assumption is that grazing by bison and other native herbivores would have involved large herds moving through an area over a very short interval. Although this makes sense, there is to date almost no data evaluating this system.

Management-intensive grazing versus “mob” grazing

What is the difference between “mob” grazing and MiG? Both these grazing tools rely on high stocking densities to achieve a goal. In the case of mob grazing, the purpose is normally to solve a particular problem, suppressing a developing weed crop, removing an over-mature sward or preparation for planting a new forage crop. Thus, it is normally just used periodically in a specific setting. On the other hand, MiG is a long-term approach to rotational grazing, one that relies not only on high stocking densities, but also on short duration entries and particularly long rest periods. Management-intensive grazing is an ongoing approach to manage an entire forage base.

However, a few observations can be made based on what we already know about forage management and native grasses. First, as has already been emphasized, any grazing practice that reduces canopies too severely will not be beneficial for native grasses. On the other hand, heavy grazing such as that imposed by MiG can diversify the plant community in a pasture. This can include many broadleaf species that we typically think of as weeds but that actually have very good nutritive values and will be readily consumed by grazing cattle. This has been borne out with PBG with a flush of forbs in the second year, following the post-fire heavy

grazing of year one. However, just as mentioned above regarding PBG, not all the plants that take advantage of open canopies in native grass stands in the southeastern U.S. will be desirable in a pasture. Of course, MiG does not necessarily have to result in very short residual stands. So, if one were to practice MiG with native grasses, it will be important to abide by the same height criteria as you would with any other rotational approach when grazing these tall-growing species (Table 10.2).

Secondly, long rest periods for native grasses, depending on the time of summer that they occur, can be a serious problem. This is because of the rapid early summer growth and decrease in forage quality as the plants mature. Even for a species like big bluestem with its relatively flat growth curve (Figure 10.6), a 60-day rest that starts in early June will, by early August, leave an extremely stemmy sward, one that has developed seedheads and has poor forage quality. That, of course, assumes that the initial graze was not severe and left adequate leaf surface area for normal regrowth. The situation could be even worse for switchgrass because of its explosive early summer growth and more rapid decline in quality following flowering. Extended late summer rest periods can have the same effect because of the time of year and influence of daylength on plant maturation and senescence.

Finally, where abundant forage mass has accumulated due to an extended rest period, there is a greater potential for trampling loss when large numbers of animals are turned in to the paddock. Advocates of MiG point to the benefit of this organic matter being trampled into the soil. However, the vast majority of soil organic matter in grasslands is derived not from above-ground plant material, but from roots and rhizomes. In fact, at a long-term research site in Kansas where, over 20 years, all above ground growth of grasses has been removed annually by burning, there has been no change in overall soil organic matter versus adjacent unburned sites. The researchers concluded that given the large contribution from roots and rhizomes, that annual removal of above ground detritus whether by fire, mowing or grazing would not influence soil organic matter levels^{54:252-253}. If complete removal of

large volumes of detritus does not change soil organic matter, it is hard to conclude that additions of small amounts of trampled forages will increase it appreciably.

There is no doubt that MiG can be used with native grasses. However, the same guidelines that have been presented in this chapter regarding canopy heights and plant maturity should be kept in mind. The cost of grazing overmature native grasses is borne out by the data in Table 10.1 (see also examples in Chapter 14, ‘Some lessons from net returns’ and Figure 14.4). Repeated severe defoliation can also be costly in terms of increased weed pressure, increased time required for regrowth and reduced pasture productivity.

WHEN TO STOP GRAZING IN THE FALL

Because they are perennials, the **native grasses being addressed in this book benefit from a period of rest prior to entering fall dormancy**. During winter, these warm-season species are still alive and, therefore, must metabolize carbohydrates to support respiration and remain healthy. Furthermore, the same root reserves that supported basic metabolism through winter also must provide the energy required to initiate vigorous growth the following spring. And all these reserves must be available at dormancy because the plants cannot resume production of new energy through photosynthesis for nearly five months.

Late-season rest allows the plant to move nutrients and carbohydrates from above-ground structures down into the root system for winter. Considerable amounts of nutrients and energy are present in above-ground portions of the plant during late summer. Removing those prior to dormancy deprives the plant of a substantial resource that would otherwise contribute to overwinter reserves. Studies have demonstrated that carbohydrate concentrations in above-ground portions of plants decline during September and October. At that same time, carbohydrate concentrations within below-ground portions of the plant increase by as much as 200-300 percent^{41; 51}.

Therefore, aggressive use of native warm-season grasses in late summer can weaken stands and increase weed encroachment, especially cool-season species, including a number of perennials, that can cause problems for many years to come. Poor management in late summer is much more unforgiving than those same mistakes earlier in the growing season. Under most circumstances, grazing can continue into early September without negatively impacting overwinter energy storage. If you have grazed continuously throughout the summer, the period of fall rest may need to be somewhat longer, perhaps as much as six weeks before the first killing frost (typically October 15 in much of the Mid-South). On the other hand, where rest has been allowed during the course of the summer as would occur with proper rotational grazing, a stand could be grazed to within about four weeks of a frost, or about September 15. **A good rule of thumb is to have stand heights of 18 inches or more at the first killing frost.**

WHAT TO DO IF YOU HAVE MADE A MISTAKE —
GOTTEN BEHIND OR OVERGRAZED?

Inevitably, in managing any forage, and native grasses are no exception, you may find yourself in a bind and asking yourself, “What do I do now?” Recovering from missteps in your native grass management is not a big deal. (Note though, that **in the first two growing seasons, the seedling year and the year following seeding, mistakes can have much greater and long-term impacts on the stand requiring greater caution during this time.**) I often say that managing native grasses is a lot like driving a car: you need to “keep it between the ditches.” So on the one hand, you could be too aggressive, overgrazing and leaving a canopy that is too short. On the other hand, you can let these fast-growing grasses get past you to where they are stemmy and forage quality has declined.

In the case of having gone off the road into the overgrazing “ditch,” all you will normally have to do is allow some additional rest. Keep in mind

the lessons that PBG and our continuous grazing trial have both taught us — these grasses are resilient. They will recover in all but the most extreme cases, where overgrazing has been persistent and/or prolonged. The more severely the stand has been overgrazed, the greater the rest period it will require to recover. You may also need to do some weed control with more severely overgrazed pastures as the reduced canopies will have provided an opportunity for many undesirable species to have become established in your pasture. Chapter 9 provides additional detail about renovating degraded native grass stands.

Regarding the overmature sward “ditch,” keep in mind that this one is less serious. Once corrected, the problem goes away, it will not persist or have negative long-term consequences. And it even provides an unintended benefit, rest and increased energy storage. There are two options for correcting an overmature stand. First, harvest it for hay as soon as possible (see Chapter 11 for more on harvesting hay). The second alternative is to mob graze it. There will be trampling loss, but you will still be able to remove most of the growth and restore the stand to a more vegetative state. Of course, there is a third alternative, one that could make sense late in the growing season and you are not pressed for forage: simply let the stand go dormant and write-off the lost grazing opportunity to experience. The excess material could be removed by grazing during winter or burned early the following spring.

BALANCING WARM- AND COOL-SEASON GRASS PRODUCTION
DURING THE SPRING FLUSH

Despite the fact that the native grasses being considered here are warm-season species, there is a period of overlap between when they become productive and when cool-season species are still very productive. This spring flush roughly corresponds to the month of May in the Mid-South. Producers who have both warm- and cool-season pastures will be faced with the question of which they should be grazing at this time. There are really only two options. The first is to stay on the

cool-season grass until it tells you it is time to move off. Depending on the spring, your location and even your management, this could be up until late June or early July. The other option is to move off the cool-season pasture when the warm-season grass is first ready to graze, early or mid-May. Which makes the most sense?

Graze the warm-season grass as soon as it is ready. Why? There are four reasons addressed in more detail below that, taken together, make this an easy decision.

First, the quality of native warm-season grass during this period of overlap is *much greater* than that of cool-season grass. Once cool-season grasses are past boot stage, forage quality declines at a more rapid rate. At this same point, warm-season species such as switchgrass, big bluestem and indiangrass are producing gains above 2.5 pounds per day (Figure 10.18). Although this rate declines somewhat in June, the gap between cool- and warm-season grasses during late spring and early summer remains. Thus, substantial gain is foregone by staying on the cool-season grass.

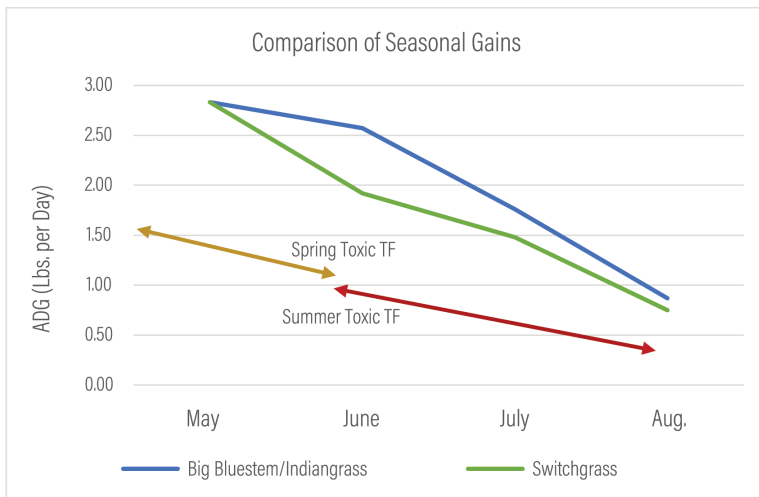


Figure 10.18. Native grasses produce excellent gains early in the season and maintain those gains into mid-summer. More importantly, the advantage in ADG versus tall fescue remains substantial until late summer. Source: M. Backus, MS thesis, University of Tennessee, 2014; Thompson et al., 1993. *Journal of Animal Science* 71:1940-1946.

A study in North Carolina provides a compelling example of the opportunity for improved productivity from grazing native grasses during spring. In this multi-year study, native grasses were grazed for 39 days (on average, April 23-May 31) while endophyte-free tall fescue and Tifton 44 bermudagrass were sequentially grazed for 56 days (on average, April 4-May 2 and May 3-31, respectively)¹⁷. The total gain per acre during this 39-day period from grazing big bluestem was 2.7- and for switchgrass 3.1-times greater than that produced by the tall fescue-bermudagrass combination — and with 18 fewer grazing days. Clearly, a substantial amount of gain would have been left on the table by not grazing the native grasses with their high rates of gain.

A second reason for moving from cool- to warm-season pastures is that, because of the rapid growth of the tall-growing native grasses during May and June, their quality will decline if left ungrazed (see section above, 'Improved summer grazing starts in the spring'). Obviously, they can be cut for hay if they do get too tall for effective grazing, but if your timing is poor, you could lose considerable potential nutritional benefit. As mentioned above where spring grazing initiation was discussed, there have been several studies in which the researchers did not use their warm-season grasses until late June or even into July. In every one of these cases, there was a substantial loss in production, more than 50 percent of the per acre beef production in one case³ (Table 10.1)!

A third reason for moving off cool-season pastures at this point is that during May and June, toxins within tall fescue are increasing rapidly, leading to reduced animal growth and reproductive performance³³. For spring herds, where April breeding is typical, having recently bred animals removed from toxic fescue is a good practice. A recent study at Clemson University found that switching bred animals to a non-toxic summer forage allowed for increased pregnancy rates, as much as 20-30 percent greater¹⁸. This same toxic forage, when conserved as hay, has much lower levels of ergot alkaloids. Therefore, the remaining cool-season forage does not need to be wasted, but rather it can be harvested as hay.

Finally, moving off cool-season forages earlier can protect that stand's vigor and longevity. Stressing cool-season grasses during summer when they are becoming semi-dormant has a greater negative impact than if that same stress occurred at a time when they were vigorously growing. Erring on the side of getting off somewhat early makes more sense than going the other way and risking pasture degradation. Recently a colleague observed that if you do not move to the warm-season grass once it is ready, you will ruin both your cool-season and warm-season forages. I think he had it exactly right.

MAKING THE BEST USE OF "SOME" NATIVE GRASSES

As you begin to incorporate native grasses into your forage system, there will be a transition period that may last for several years during which you are moving towards a long-term acreage goal. During this transition, or in any other scenario that puts you in the position of having limited acreage in native grasses, what is the best way to use them?

Let me start by addressing one approach that I would encourage you to avoid: simply building those few acres into your normal rotation. In that scenario, cattle will be going onto the native grasses, adjusting rumen microbes to a new forage, and just when they have made that adjustment, they will be switched to a different forage, requiring some level of adjustment all over again. Moving from one grass type to another is not as big a deal as switching from grass to a grain-heavy diet, for instance, but there can still be an adjustment period. When the forage they are going back to is a toxic endophyte-infected tall fescue (like KY 31), that return trip can be rough. Such switching back and forth can wash-out some of the forage quality advantage of native grasses.

A better alternative would be to use the higher quality native grasses to optimize performance for a subset of your herd. Using the native grasses for heifer development might be the first priority. These animals are typically more sensitive to fescue toxicosis, require adequate rates of gain and are important to get and keep bred. A similar approach would

be to put second-calf heifers on the native grasses. Re-breeding these animals can be an issue and having a high quality, non-toxic, low-cost forage would help minimize rebreeding problems.

Another good option, for fall-calving herds anyway, is to use the limited acres of native grass pasture for backgrounding calves. If you are weaning fall calves in May, that is perfect timing for moving these calves onto a forage that can produce more than 200 pounds of gain per head for as little as \$0.25-\$0.30 per pound over a 90-day summer grazing season. As addressed in Chapter 14, this approach provides consistently positive rates of return. For heifer calves, these same forages can provide a good leg-up on development and attaining puberty in a timely and cost-effective way.

During drought periods, taking advantage of the more reliable summer production is also a benefit a few acres of native grasses can provide. During such droughts, heifers should still be a priority for using the native grasses, but in fall herds, third-trimester cows may also be a consideration. Strategic use of small acreages of native grasses under one of the approaches described above can assure you get the best return on investment in the short run.

SUMMARY

For proper grazing management of native grasses, it is important to know that, like any perennial grass, energy balances matter, persistent overgrazing negatively affects those balances and plant maturity negatively impacts forage quality. It is also important to recognize that because these are tall-growing species they must be managed with taller canopies. A good rule of thumb is to be sure that the canopy always remains above the top of your boot but below your hip throughout the summer season. When persistently grazed below that range, they can weaken and become weedy, reducing productivity. When allowed to get above that range, they can, because of their rapid growth rates, get stemmy and have reduced nutritive value. For these reasons, you will

need to be prepared to pay closer attention to canopy condition and to make stocking adjustments more frequently than what you may be used to with some other common forage grasses. And as long as these height guidelines are followed, native grasses can be grazed by a number of different methods—rotational, continuous, PBG, MiG or about any other approach you care to try. Do not be overly concerned about making mistakes once stands are well established, that is, those stands that are three or more years old. Experience has shown that these grasses are resilient and can recover from overgrazing by simply providing some additional rest. What they will not tolerate though is sustained, repeated close defoliation. As long as these basic principles are kept in mind, native grass pastures are not difficult to manage.

CHAPTER ELEVEN

Hay Production

Native grasses can produce large volumes of high-quality hay. And because these grasses generally produce more tons per acre than annuals or cool-season perennials, hay production targets can be achieved from fewer acres, freeing up land for additional pasture or other purposes. As explained in detail in Chapter 14, native grasses produce hay at a lower cost per ton than is possible with annuals and cool-season perennials. Furthermore, because of the drought resiliency of the native warm-season grasses, they will produce more reliably year in and year out. And, as mentioned in Chapter 3, native grasses do not have the nitrate or prussic acid toxicity issues of johnsongrass or many of the summer annuals. Finally, optimum maturity for hay harvests occurs later in the



Figure 11.1. Native grass hays can be harvested with the same equipment that is used for any other forage crop. No specialized equipment is needed.

season than it does for cool-season grasses, a time of year that typically has better weather for curing hay. Taken all together these grasses can be a valuable tool to meet hay production needs. However, like all hay crops, there are some guidelines that must be followed to ensure you get the most out of the stand. Of particular importance are cutting height, timing and frequency of harvest.

No specialized equipment is needed to produce native grass hay (Figure 11.1). The mowers, tedders, rakes and balers you use for any other hay crop will work fine with native grasses. With lowland switchgrass, where harvests have been delayed and hay volume is particularly high, throughput can be a concern, but even then, traditional equipment has proven adequate to handle these volumes.

CUTTING HEIGHT FOR HARVESTING NATIVE GRASS HAY

A good place to start the discussion about harvesting native grasses for hay production is to consider the primary difference between these species and many of our conventional hay crops. As explained in the preceding chapter, the native grasses being considered here all have a tall growth habit. Consequently, cutting heights should be higher than for those species with shorter growth habits such as tall fescue, orchardgrass, bermudagrass and many other forages. For hay harvests, all the principles important for grazing remain applicable (see Chapter 10). Therefore, to maintain high yields and long-term stand vigor while ensuring good quality hay, you must avoid removal of growing points, avoid cutting too short and allow ample rest and recovery between harvests as well as at the end of the growing season. However, the harvest heights of 14 inches or more recommended for grazing are not practical, or necessary, for hay production. **For all native grasses, the standard recommendation for hay harvests is to leave an 8-inch stubble height.** Unless harvests are unusually late in the season, this target height will always protect the growing point. Such harvest heights will also allow some leaf surface area to be left behind that will contribute



Figure 11.2. Stubble from a late hay harvest. Although this stand should have been harvested about three weeks sooner and as a result had become somewhat stemmy, it does make clear that low harvests on native grasses do not offer much additional forage. At about 8 inches cutting height, very little forage is left in the field.

to more rapid recovery of the stand following harvest. Furthermore, because of the growth habit of these grasses, cutting at lower heights will add very little to hay yields. Overall tonnage may go up very slightly, but any gain here will be based on additional stem and not leaf material. This is because native grasses have very little foliage close to the ground (Figure 11.2). In fact, in one study of switchgrass harvest heights, there was no improvement in yield between stands cut at 4 inches and those cut at either 8 or 12 inches. It was not until cutting height was increased to 16 inches that there was a loss in yield⁵.

It is also worth pointing out that hay harvests create greater stress on the stand than appropriately managed grazing. Properly managed grazing, as explained in the preceding chapter, will always leave ample leaf surface area and, therefore, a robust canopy and a strong root system. Hay harvests, on the other hand, result in almost total defoliation of

But I can't raise my mower to 8 inches!

When the recommendation to maintain harvest heights of 8 inches is made, most growers will raise the objection that this is not possible with their equipment. In East Tennessee, a large number of growers that were producing switchgrass were, in every case, able to achieve 8-inch stubble heights. How did they do this? By using one of the following methods to adjust their mowers. One of the cheapest and easiest is use of cylinder stops (also known as stroke-limiting collars) (Figure 11.4). Placing these on the hydraulic cylinders of the mower can limit the amount of drop when the mower is lowered. Trial and error can lead to the correct number and size of collars for any given mower. A second, and very reliable method is to use skid shoes. Some mowers come with these already and they simply need to be adjusted to achieve the correct amount of clearance for that particular piece of equipment. For other mowers, aftermarket kits and/or skid shoe spacers can be purchased to retrofit the equipment. Finally, a skid shoe can be fabricated to adjust your mower (Figure 11.5). One other method is to adjust the cutter bar angle. For each of these methods, consult your owner's manual or equipment dealer for details specific to your mower.



Figure 11.4. Mowers can be adjusted to cut native grasses at a proper height, about 8 inches, by several means. One of the easiest is to use cylinder stops as seen here. Credit, J. Walton.



Figure 11.5. Skid shoes are another effective way to adjust mower height. Such shoes may already be on the mower, can be purchased as an aftermarket accessory or, as seen here, can be fabricated. Credit, J. Walton.

the plant. Consequently, repeated short cutting heights over a period of years will severely weaken native grass stands. This was borne out in a 4-year switchgrass harvest study during which 16-year old stands were cut twice each year (June 18 and August 21, on average across all four years) to one of four stubble heights: 4, 8, 12 or 16 inches. At the conclusion of this study, when the stand was 20 years old, plots cut to the shorter heights thinned out substantially and had a large increase in weeds (Figure 11.3). Admittedly, younger, more vigorous stands may have been somewhat more tolerant of close cutting, but this study makes clear that shorter heights can, over time, be a serious issue for stand vigor. In Kentucky, a switchgrass biofuel demonstration study was established in which the switchgrass was harvested only once per year late in the fall. The stands were all in excellent condition when they were turned back over to the farmers at the conclusion of the project. Some of the farmers started cutting the switchgrass for hay using the same management practices that they used for their cool-season grass hay

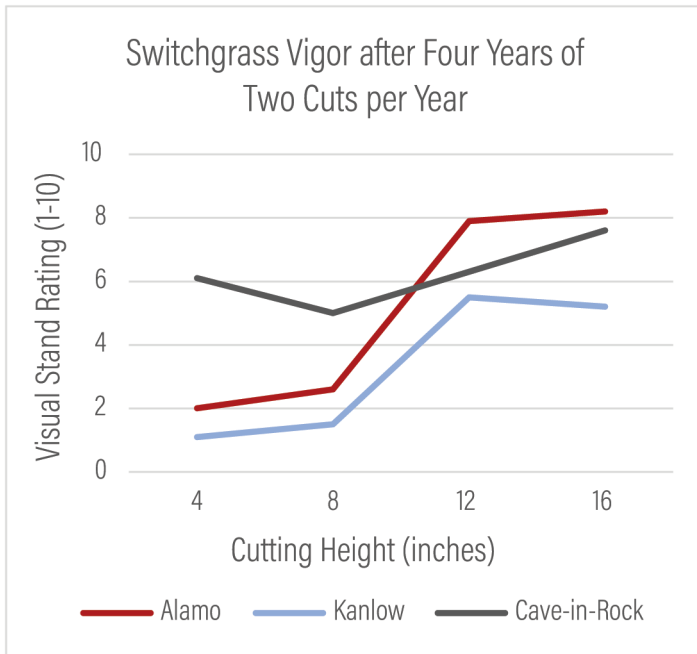


Figure 11.3. Twenty-year old switchgrass stands had been harvested at one of four heights twice per summer for the four previous years. Stands were weaker that had been harvested at the lower residual heights. Adapted from Ashworth et al., 2013. *Forage and Grazinglands*. DOI 10.1094/FG-2013-0043-RS

fields. On average, they cut twice per year with their disc mowers set for a 2-3 inch cutting height. The majority of these stands had become very thin after just two years of this cutting management.

Many producers wonder how they can practically achieve the 8-inch cutting recommendation. While existing disc mowers normally are set to cut much lower, there are a number of adjustments that can be made to raise the mower and increase cutting heights (see sidebar). It is worth emphasizing here that all hay fields, regardless of species, would remain in better shape — more vigorous grass, less recovery time, fewer weeds — if mowers were raised. While for the tall-growing native grasses the target height will always be greater than that for species such as tall fescue or orchardgrass, even those shorter-stature species will benefit from leaving more leaf surface area following harvest.

Another outcome from the greater harvest heights, one that you might not have expected, is shorter curing times. The 8-inch stubble actually serves to suspend the mown hay above the ground, which allows for better air circulation. Consequently, native grass hays can cure in as little as 24 hours during midsummer with good drying conditions. Being able to make hay during narrower windows between forecast rains lends additional flexibility to producing hay with these species.

Does native grass stubble damage equipment tires?

In recent years, lowland switchgrass, which can produce very large stems, has been harvested for biomass production. In this scenario, there is only a single annual harvest, which takes place following fall dormancy. Under these circumstances, the stems of this robust grass reach their maximum development and can be as much as one-eighth of an inch in diameter. When such large stems are cut close to the ground, below about 6 inches, they do not have the ability to flex as tires cross them. Such stems have caused damage to field tires and those on ATVs. However, when managed as a hay crop, native grasses are harvested at a much earlier stage of maturity and, as a result, stems remain small and flexible. Similarly, with grazing management, stems never reach full size and, therefore, remain flexible. Furthermore, when switchgrass harvested as a biomass crop was cut to an 8- rather than a 6-inch or less stubble height, the stiff stems were able to flex under tire traffic and tire damage was eliminated. Thus, under hay harvest, where stems never get so large and harvest heights are kept to 8 inches, tire damage is not an issue. This has been borne out by the experience of many producers, even those growing lowland switchgrass for hay, who have never experienced any issues with equipment tires.

TIMING AND FREQUENCY OF HAY HARVESTS

A second area where there are some differences between native grasses and other more familiar hay crops is the timing and frequency of harvests. As warm-season species, native grasses will normally be cut later in the season than cool-season grasses. And because of their tall growth habit and how that impacts energy balances in the plant (see Chapter 10), they should not be cut as frequently as grasses with shorter growth habits.

Timing hay harvests

Timing of initial hay harvests for native grasses will be controlled to some extent by having enough forage to make the cutting worthwhile. And as with any hay crop, waiting too long for the initial cutting will result in more advanced plant maturity and, therefore, reduced forage quality. The standard recommendation for timing of hay harvests for native grasses is the same as that for other forage crops and is based on balancing yield and quality. This balance is best achieved by **timing harvests at the boot stage, before emergence of any seedheads** (Figure 11.6).



Figure 11.6. This stand of switchgrass was photographed on May 24 and is at an ideal stage to take a first hay cutting (a). Likewise, the big bluestem hayfield (b) photographed on June 25 is also at an ideal stage of maturity to take the first hay cutting. Note that neither field has yet developed seedheads. The vegetative material will provide high quality hay in both cases.

Among the native grasses, the species that is most sensitive to harvest timing is switchgrass. It makes a good illustration of why early harvests are important. During a three-year trial at the University of Tennessee, lowland switchgrass was harvested at boot stage (average date, May 26) and at early seedhead stage (average date, June 22) each year^{42; 43}. Although there was a large increase in yield over this 27-day interval, from 3.5 to 5.5 tons (dry matter basis) per acre, there was also a substantial penalty in forage quality. The material harvested in late June was very stemmy compared to that cut in May. In terms of laboratory tests, CP declined from a respectable 10.7 percent to 8.7 percent. Fiber content (NDF) increased from 68.5 percent to 73.0 percent while total digestible nutrients (TDN) were 56.6 percent for the early harvested hay and 52.9 percent for that harvested late.

I have been told by folks who have put up very poor-quality switchgrass hay that their cattle will only pick at it. I am also told by others who have put up switchgrass hay that it is very good. Their cattle readily eat it, in some cases even prefer it, and appear to do well on it. Both groups of producers are correct. The difference between them is simply a question of harvest timing. Switchgrass cut in the boot stage will be of very good quality and be readily eaten by cattle. That cut late, after substantial seedhead emergence across the stand, will indeed be low in quality. The other native grasses are more forgiving of timing, but regardless, the lesson is the same, cut on time, at boot stage, before you see seedheads, and you will have good to excellent quality hay^{61; 21}.

While the actual dates will always vary depending on spring and early summer weather patterns, the following will serve as a rough guide of when you can expect these plants to have reached boot stage and be ready for an initial hay harvest. These dates are based on the Mid-South, so you will need to make adjustments for your location based on latitude and, in mountainous regions, altitude. For eastern gamagrass, an initial harvest may be possible as early as May 20-25. For switchgrass, the initial harvest should take place about 1-2 weeks later than that for eastern gamagrass, about May 25-June 1. Big bluestem, little bluestem

and indiangrass, often mixed in the same field, generally will be at boot stage and ready for an initial harvest about June 20-25. If you have a stand dominated by indiangrass, the harvest date would be about 1-2 weeks later than for one dominated by either of the bluestems.

Late season harvests should be avoided for native grasses. This is because nearly total defoliation of the plants late in the season will deprive them of considerable stored energy, not only that which was in the above ground portions of the plant, but also the root reserves required to regrow all the leaves removed by the harvest. This same issue was addressed for late-season grazing, but in the case of hay harvest, the impact will be greater for the reasons just mentioned. **A good rule of thumb is to forego any hay harvest after August 25**, certainly after September 1 in the Mid-South. At this point in the season, there is very little time left for the plants to recover lost energy before fall

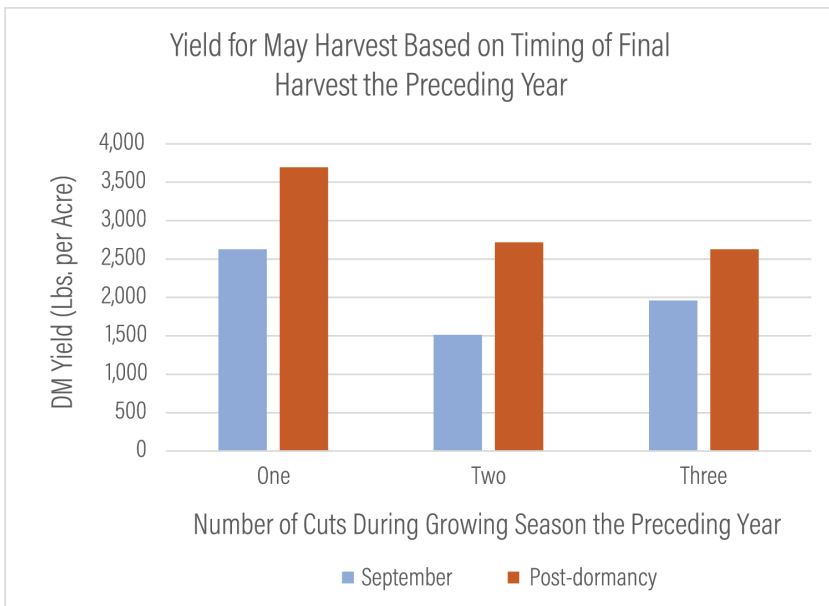


Figure 11.7. Yields for switchgrass were influenced by both the number and timing of the previous year's cutting. More cuts during the preceding year reduced current year yields. Timing of those harvest was also important with late growing-season harvests having a disproportionately negative effect on current year yields. Adapted from Sanderson, 2000.

dormancy. The initial thought in letting what may appear to be a good cutting go unharvested is that it is a lost opportunity, wasted forage. But in the long run, the stand receiving appropriate rest, especially late in the growing season, will out yield stands that are pushed too hard in the short term. In a Texas study, stands of switchgrass harvested in September were compared to those harvested after fall dormancy. The plots cut after dormancy, when nutrients had been moved back into the roots, had considerably higher yields for the first cutting the following spring (averaged 50 percent higher) than those that had been harvested in September (Figure 11.7).

Harvest frequency

Second cuttings are generally possible for native grasses and should similarly be timed to achieve a balance between forage yield and quality. In most circumstances, 6-7 weeks will provide the appropriate regrowth and stage of plant maturity necessary for the second harvest. Eastern gamagrass can sustain two harvests annually; in some years, three cuts may be possible without weakening the stand. For switchgrass and stands of various mixtures of big bluestem and indiangrass, two cuts per year will normally be possible. In the case of the big bluestem and indiangrass, you may want to forego a second harvest every few years to allow the stand to remain vigorous.

A good example of the importance of avoiding excessive harvest — as well as low cutting heights — comes from a recent study at the University of Tennessee. In this study, lowland switchgrass was harvested either two or three times per year at either a 3- or 8-inch height. Furthermore, the timing of these low or high cutting heights was varied with both cuts at 3 inches, both at 8 inches, the 3-inch cut first followed by the 8-inch cut or the 8-inch cut first followed by the 3-inch cut. Finally, three cuts all at either 3 inches or all at 8 inches were included. Altogether, six harvest scenarios (Figure 11.8). This study made clear that three cuts per year was not sustainable; the switchgrass stands were severely degraded. It also made clear that harvests at a 3-inch height,

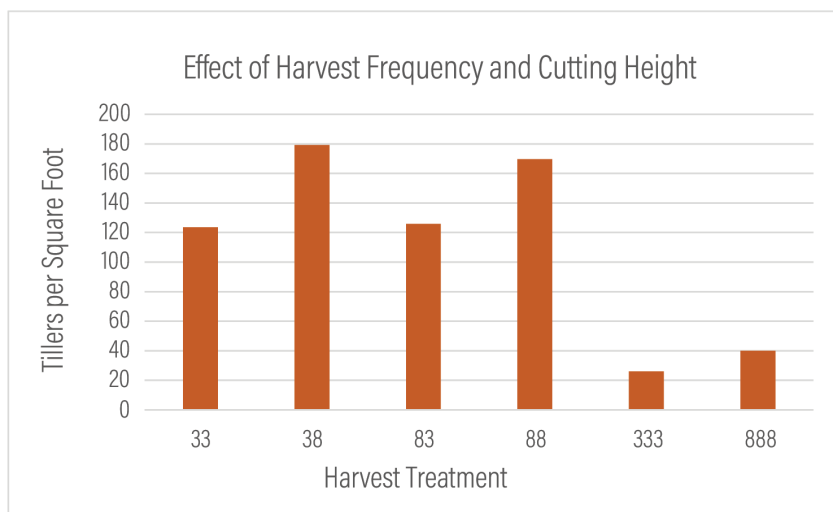


Figure 11.8. Lowland switchgrass tiller density was affected by the number and height of harvests. Harvests included two cuts at 3 or 8 inches designated by '33', '38', '83', or '88', or three cuts at either three (333) or eight (888) inches. Over four years, three cuts per year were clearly detrimental to stand vigor. Harvests with greater residual heights, especially later in the season, also maintained greater stand vigor. University of Tennessee, unpublished data.

the height most disc mowers are set to, reduced stand vigor more than those at 8 inches and low cuts later in the season were more detrimental than those in early summer.

Limit hay harvests to a single cut early in the season if you see stand thinning, a reduction in the number of tillers per plant, increased weed pressure or a trend towards reduced yields. Allowing the stand to rest for the remainder of the season will allow it to strengthen and remain productive. As mentioned regarding foregoing late harvests, skipping a second cutting may seem counterproductive at first, but in the long run doing so will allow the stand to yield more tonnage and remain productive over a greater number of years. Indeed, more frequent harvests will not translate into greater yields over the life of the stand (Figure 11.9).

NATIVE GRASS FORAGES FOR THE EASTERN U.S.

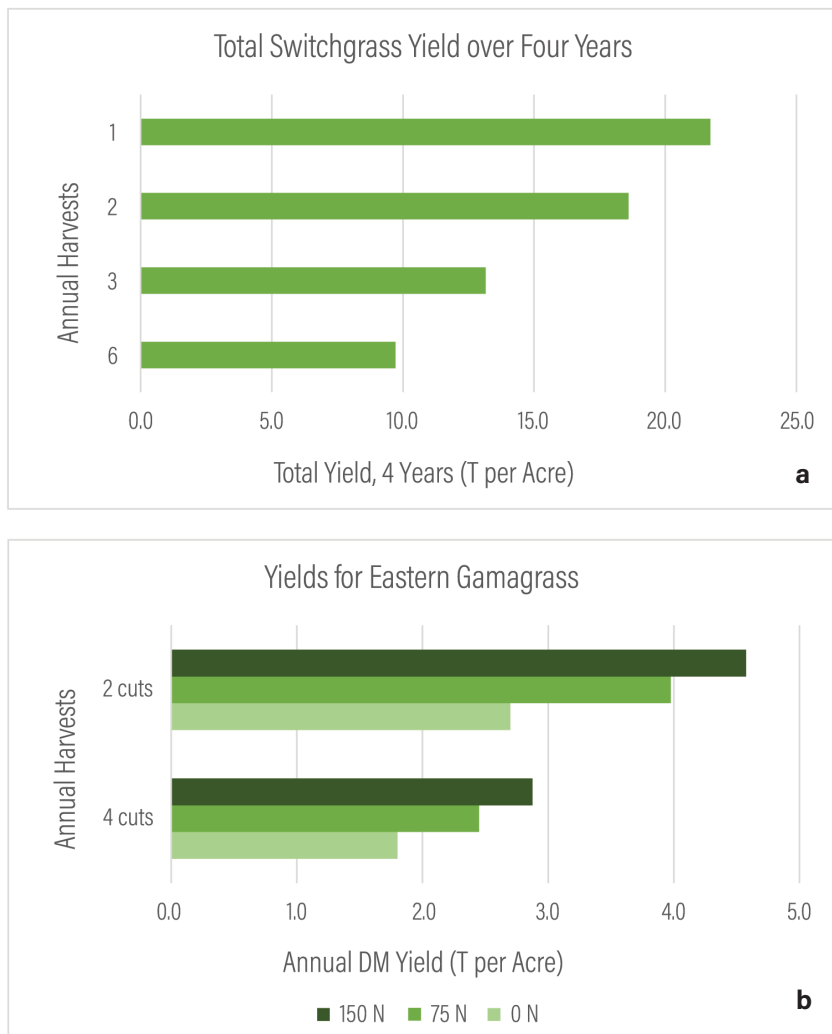


Figure 11.9. Yields for tall-growing native grasses decrease with too many annual harvests. During a four-year study in Mississippi, cumulative yields of switchgrass declined with each additional harvest (a). Two annual harvests for this species are likely optimal in most cases. Similarly, for eastern gamagrass, two annual harvests are more productive than four (b). Source: (a) Seepaul et al., 2014. *Agronomy Journal* 106:1805-1816; (b), Virginia Tech, unpublished data.

HAY YIELDS AND NUTRITIVE VALUE

Yields for native grass hay can be quite high, but depend on site quality, stand quality, fertility management and harvest timing. Several recent variety trials conducted in the eastern U.S. provide some reasonable estimates of expected hay yields for several species of native grass (Table 3.2). Across all species and locations, the average annual yield in these trials was 4.3 tons (dry matter basis) per acre. That yields can vary a good deal based on site becomes apparent when looking at yields of indiangrass, which were 4.7 tons per acre in Tennessee and only 2.0 tons in southern Mississippi. While some of this difference could be a result of other factors, the most obvious explanation is that the Mississippi site is on deep sands while the site in Tennessee is a more productive sandy loam. Another important consideration in looking at average yields is that they are, in fact, averages and have been taken over many years. From year-to-year, actual yields can vary a great deal. While rainfall patterns obviously influence yield, there is still much of this annual variability that cannot be tied to precipitation. For example, the harvest yields presented in Figure 3.8 range from 7-15 tons per acre over a 13-year period. What drove that variability? No one knows, but it was not rainfall; there was no statistical correlation between rain and yield in that study. Interestingly, there was a similar pattern in yields over a 7-year period in a variety trial that included big bluestem (2.6-6.4 tons per acre) and indiangrass (2.4-6.2 tons per acre). And again, it is not clear what caused this variability.

Other factors that will certainly influence yield and that are under the control of the grower are stand quality, fertility inputs and harvest management. Thinner, weedier stands will produce less through the years than those that are well-stocked and have limited weed pressure. This is a good reminder that establishment success will follow you for many years after planting and reinforces the importance of paying attention to detail during that process. It is also a reminder that good management maintains vigorous plants, which minimize weed pressure and, thus,

pays a dividend in increased yields over time. Fertility management is addressed in Chapter 12, but put simply, increased fertility inputs can increase yields, at least in the case of N. And as described in the preceding section, harvesting the stand too short, too frequently and too late in the season will all lead to decreased yields over time. In any given year, you could get a short-term increase in yield by additional harvests, but it is not a sustainable approach.

Nutritive value of native grass hay

As mentioned above, hay nutritive values will vary based on several factors. Unlike yield though, a single factor exerts tremendous influence on nutritive values of hay: stage of plant maturity at harvest. Regardless of the species in question, harvests should occur before seedheads have developed. More frequent harvests, which maintain the stand in a more vegetative condition, will keep leaf:stem ratios higher and maintain plants with younger leaves. Together, these factors result in improved nutritive values. Based on several trials, it is clear that for native grass harvested at boot stage, forage nutritive values are good but will decline with increased plant maturity (Table 11.1).

Studies with eastern gamagrass have shown modest improvements, as much as two percent greater CP level, with N amendment⁴⁷. Similar results have been reported for other species of native grasses with improvements of about 1-2 percent in CP levels, for example, from 8.5 to 10.4 percent in a June sample of big bluestem^{12; 53:16}. Fiber and energy levels are usually not increased by fertilization, except perhaps indirectly where more rapid growth results in harvests at later stages of plant maturity. Prescribed burning can also positively impact forage quality and is addressed further in Chapter 17. Increased nutrient concentrations of grasses following burning typically only persist for about six weeks following the fire. Site quality, which can strongly impact yield will normally not affect the quality of the forage, except perhaps in extreme cases.

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Table 11.1. Forage nutritive values for native grass hays cut at various maturities.

Species	Harvest	CP %	NDF %	TDN %	Reference
Switchgrass (Alamo)	boot stage, 1st cut	10.7	68.5	56.6	McIntosh and coworkers
Switchgrass (Alamo)	early seedhead stage, 1st cut	8.7	73.0	52.9	McIntosh and coworkers
Big bluestem/ indiangrass blend	boot stage, 1st cut	11.5	64.8	57.9	McIntosh and coworkers
Big bluestem/ indiangrass blend	early seedhead stage, 1st cut	9.3	66.8	56.8	McIntosh and coworkers
Big bluestem (avg., seven varieties)	late boot, 1st cut	9.2	67.9	58.8	Richwine and Keyser
	seedhead, 1st cut	6.8	74.6	54.7	Richwine and Keyser
	seedhead, 2nd cut (September)	6.3	73.7	53.5	Richwine and Keyser
Indiangrass (avg., six varieties)	late boot, 1st cut	10.0	66.7	58.6	Richwine and Keyser
	seedhead, 1st cut	7.4	73.5	55.6	Richwine and Keyser
	seedhead, 2nd cut (September)	6.3	73.2	53.4	Richwine and Keyser
Eastern gamagrass	45-day intervals	10.0	68.0	-	Grabowski and coworkers

Forage test results for native grasses

As with other warm-season species, forage test results for native grasses are lower than what we expect with cool-season grass forages and even many of our summer annuals. For example, we can compare native grasses (Table 11.1) to samples submitted to the University of Tennessee's Soil, Plant, and Pest Center from across Tennessee. Based on these samples, which are of unknown stages of maturity at harvest, average test results for tall fescue were 11 percent CP, 57 percent TDN and 64 percent NDF. For orchardgrass samples, average forage nutritive values were slightly better at 13 percent CP, 61 percent TDN and 63 percent NDF. Based on these lab tests, it is clear that these cool-season grasses have better test outcomes than do native grasses.

Why is this? There are really two answers to that question. First, all warm-season grasses, especially perennials such as switchgrass and

big bluestem, have inherently higher concentrations of fiber than cool-season grasses. Therefore, we expect higher NDF and lower energy (TDN) levels. A second issue is that although our lab test techniques are good, they cannot exactly replicate what is happening inside a rumen. A study conducted several years ago by Gerry Jung and his associates confirmed this, reporting that **traditional lab analyses underestimate digestibility of native grasses by about 20-35 percent** versus results from animals³¹. In fact, based on a more recent study in North Carolina, dry matter intake and dry matter digestibility for switchgrass and big bluestem hays projected to an ADG for steers of 1.5 pounds per day or more¹⁶. That is certainly not a “low quality” forage!

Another issue with these forage tests is that native grasses have a higher level of “bypass” proteins. These are proteins that are not degraded in the rumen and enter the small intestine where they are absorbed by the animal, thus named because they bypass the rumen. These bypass proteins are more valuable to the animal in terms of performance than ruminally-degraded proteins. In warm-season grasses, including native grasses, proteins are more resistant to microbial digestion in the rumen because of the type of cells in which they occur within the plants. In a study conducted in Nebraska, it was found that the proportion of bypass proteins in switchgrass was more than double that for a cool-season species, smooth brome⁴⁸. Likewise, the concentration of bypass proteins in that study was greater in switchgrass. Across a number of studies that included switchgrass, big bluestem and indiangrass, **bypass proteins averaged about 45 percent of the total proteins. By comparison, for the cool-season grasses, the average was only about 14 percent**⁵³.

The combination of the underestimate of both digestibility and proteins likely explains at least part of the gap between animal performance from native grasses and the lab tests. Regardless of the explanation though, the animal itself is always the ultimate test of the quality of any forage. And as described in Chapter 3, animal performance on native grasses is very strong, indicating high forage quality. So, do not

let lab tests discourage you. Look instead at how the animals are doing on these forages.

SUMMARY

With attention to cutting height, harvest timing and harvest frequency, native grasses can provide a large supply of good quality hay over many years — and do so from fewer acres than cool-season grasses due to their greater per acre yields. Better still, they can do so in a cost-effective manner. Production of hay from native grasses mainly differs from other forage crops in the requirement for **greater stubble heights (8 inches)** to avoid weakening the stands. Adjustments to your mower with cylinder stops or skid shoes may be necessary to be able to cut at this greater height. Also, cutting frequency should typically only be twice per year and harvests after late August should be avoided. And, as with all hay production, timing of harvest with respect to plant maturity will govern both yield and quality of the hay produced. For native grasses, as is the case with other grasses, **hay should be cut at the boot stage** to ensure a balance between quality and yield. Finally, despite what may appear to be poor test results for native grass hays, they are readily consumed by cattle and meet nutritional needs at a level much greater than the tests would lead you to believe.

CHAPTER TWELVE

Fertilizing Native Grasses

Native grasses are known for their ability to be productive on poor sites and under relatively low fertility environments. Furthermore, much of the past research suggests that native grasses show limited response to fertilizer amendments or lime application. None of this means that they do not need the soil nutrients, but rather that they are able to take advantage of low nutrient environments for a variety of reasons explained in more detail below. Regardless, good fertility management is always important and consistent responses to N amendment show that it can be important under production situations. In this chapter, information on nutrient needs of native grasses and how to best manage fertilizer inputs is provided.

NUTRIENT NEEDS OF NATIVE GRASSES

As mentioned in Chapter 1, the native grasses important for forage production appear to have originated from the southeastern U.S. and are considered to be subtropical grasses. What does this have to do with nutrient needs? Simple. Subtropical grasses are well-adapted to subtropical soils. And subtropical soils are typically highly weathered (think red clay here) and as a result have high acidity, low available N and P. So, for a grass to thrive in such environments, it must have adaptations that fit those conditions. As mentioned in Chapter 1, some native grasses that are not desirable for forage production do well in poor soils. A good example of this is broomsedge. We often find it thriving where introduced forages are struggling. While this may occur as a result of management — persistent overgrazing — it can also happen simply as a result of soil acidity and fertility (Fig 12.1).

What are some of these adaptations? Let's start with P, perhaps the easiest to explain in terms of native grasses. As mentioned in Chapter 1, the native grasses we are considering here all have symbiotic relationships with mycorrhizae through which P is made available to the grass plants. In one study of indiangrass there was a 99 percent colonization rate of the roots by mycorrhizae. In a recent study in Tennessee, the rate was 84 percent for both switchgrass and big bluestem (Fig 12.2). Furthermore, studies have shown substantial growth responses to mycorrhizae colonization and, for big bluestem, these fungi help the plants to revegetate in response to grazing²⁹. Thus, **even in low-P environments, and with the help of the mycorrhizae, native grasses are able to meet their needs.**



Figure 12.1. What had once been a tall fescue field is giving way to broomsedge, a native warm-season species. This is a common problem throughout the Fescue Belt and results from the ability of broomsedge to thrive in acidic, low fertility soils. Similarly, most native grasses being considered in this book can thrive under conditions that are marginal for more nutrient-sensitive, introduced forages.

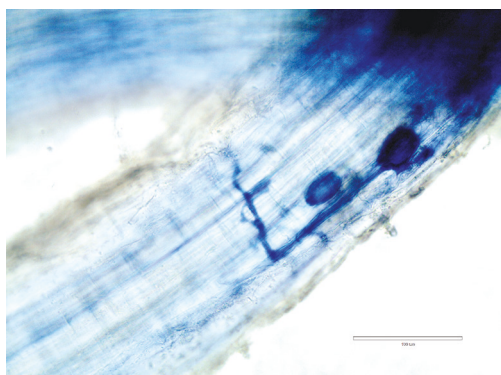


Figure 12.2. Mycorrhizae such as seen here with this vesicle, are associated with native grasses and make P available to them. As a result, the native grasses are able to thrive in soils poor in P and have not been shown to respond to amendments of P. Credit, D. Butler.

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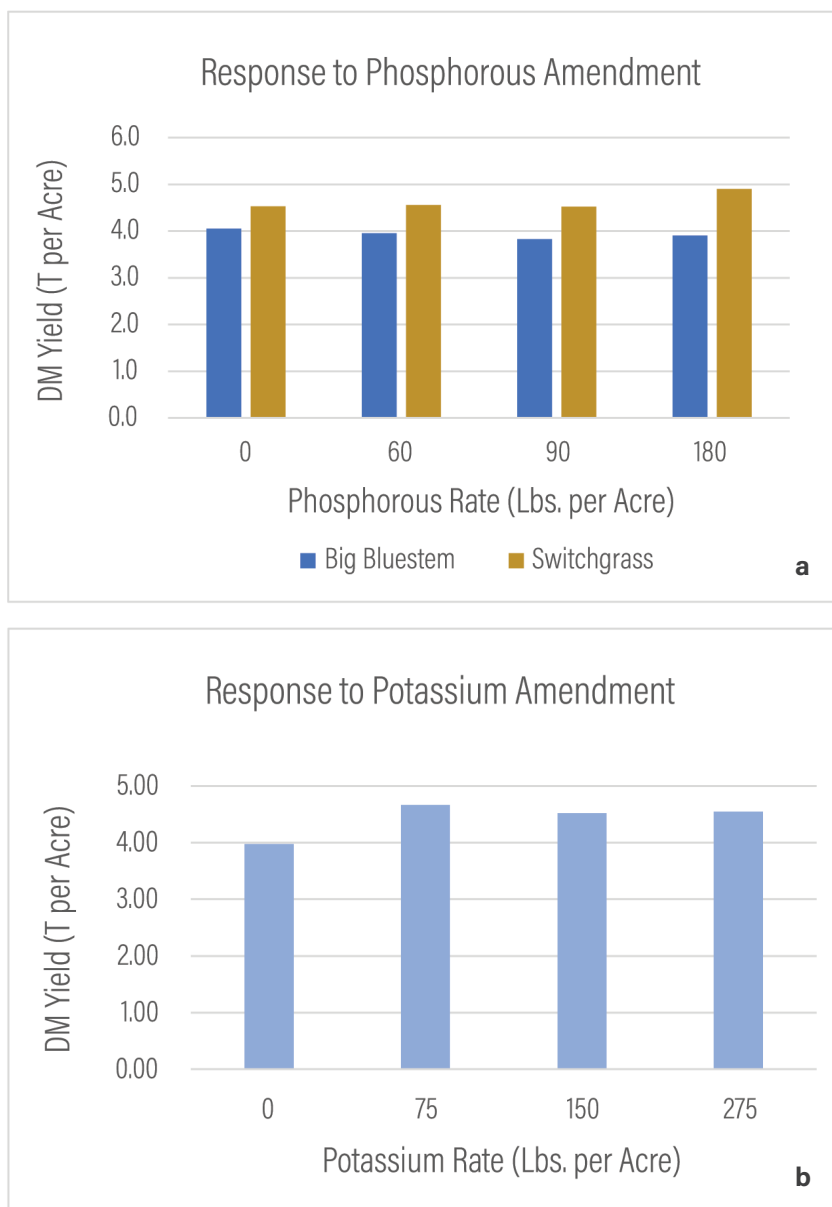


Figure 12.3. During seven years, neither big bluestem nor switchgrass showed any yield response to P amendment on low P soils (a). For potassium, no response was detected for big bluestem, but at one of two locations, switchgrass did respond to K amendment at the lowest levels, an increase of 0.6 tons per acre going from 0 to 75 pounds of K per acre (b). University of Tennessee, unpublished data.

A good example of this benefit was demonstrated by a study conducted many years ago in Pennsylvania by Gerry Jung and his associates⁴⁵. In that study, they found that on soils very deficient in P (5 ppm), big bluestem, little bluestem and switchgrass out-yielded cool-season species by as much as three times. On the other hand, the native grasses all had lower concentrations of P than did orchardgrass or tall fescue. Despite substantial P amendments (400 pounds per acre resulting in 35 ppm soil P), neither big bluestem nor indiangrass yields increased. By contrast, the cool-season species had 35 percent greater yield in response to the additional P. Similarly, in a trial conducted in Tennessee on low-P soils (approximately 5 ppm), neither switchgrass nor big bluestem showed any response over the 7-year study to P amendments up to 180 pounds per acre (Figure 12.3a).

Native grasses also have low K requirements and are often able to meet their needs for this nutrient even in K-limited soils. Furthermore, most studies in which K has been applied to native grasses have not shown responses in yield or improvements in forage quality¹². However, many of these studies were conducted in the Great Plains. More recent research conducted in the Southeast where soils are quite different has shown some limited positive response to K amendment for switchgrass. For instance, during a recent trial at the University of Tennessee, switchgrass at one of two locations showed a response to K, but only at the lowest levels (Figure 12.3b). Similarly, a recent study in Arkansas reported a positive response to K for switchgrass yield up to 300 pounds K per acre. However, the increase in yield was modest at about 1.3 tons per acre when 150 pounds of K, near the optimum input level, were applied. It should be noted though that this response to K occurred with high input levels of both N and P, 200 pounds per acre of each⁵². During the University of Tennessee study, no response was observed to K amendment for big bluestem.

Nitrogen

In the case of N, native grasses start at an advantage because they have greater N-use efficiency and, thus, have lower N requirements^{13; 14}. An

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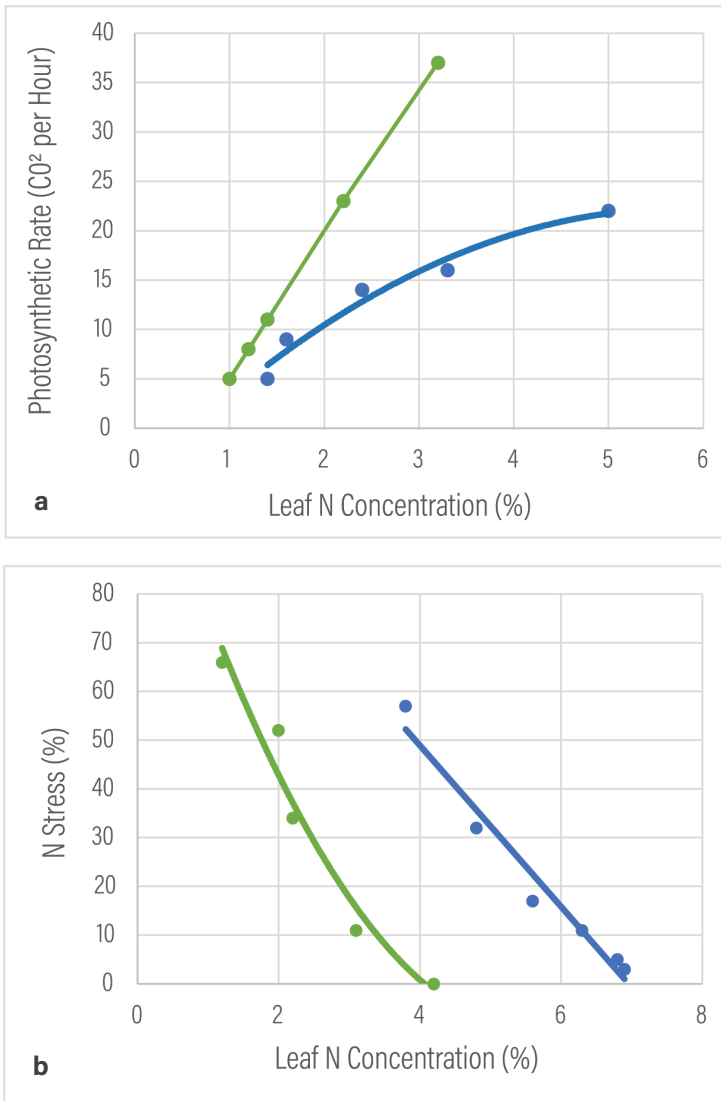


Figure 12.4. Warm-season grasses, those with C_4 photosynthesis, are able to achieve much greater photosynthetic rates at low levels of N as seen in this comparison (a) of a cool-season species, perennial rye (blue line) and a warm-season species, guineagrass (green line). In this case, the C_4 species has more than twice the photosynthetic rate at 3 percent N as the C_3 species. Cool-season species also require greater N to reach their full growth capacity, about 7 percent N , compared to C_4 species, which only require about 4 percent N (b). At that same level (4 percent N), the C_3 species is only achieving about 50 percent of its growth potential. (Adapted from Brown, 1978. *Crop Science* 18:83-98.

experiment comparing C3 and C4 grasses demonstrated that the C4 species had growth rates and root weights twice as high as those of the C3 species but at the same time had lower concentrations of N within their plant shoots (Figure 12.4). Thus, at low soil N levels, C4 grasses can produce more growth than their C3 counterparts. This adaptation likely goes back once again to the association of subtropical grasses with weathered, N-poor soils.

In addition to the lower demand for N, there are several mechanisms that account for the ability of the native grasses to remain productive in soils where N is limited. One source of N for these species appears to be free-living and/or associative N-fixing bacteria. Studies have documented these species occurring with native grasses^{12; 8:228}. To date though, it is not clear how much N they make available to the grasses. However, one recent study placed it as high as 30-50 pounds of N per acre⁵⁷. The second mechanism that may explain lower N requirements for native grasses is mineralization, that is, the process whereby plant-available N is released into the soil from decaying plant material, especially roots. Because of the amount of root mass produced by these species and the large pools of organic matter they create within the soil, there is considerable potential for these plants to derive part of the N they need from this process. Another piece to the puzzle is the movement of N from above ground parts of the plant back into the roots each fall. In a study of big bluestem, 58 percent of the N within leaves was translocated back into the roots before dormancy^{8:236}.

Despite the efficiency with which native grasses use N, they clearly respond to supplemental N. Switchgrass, which has been studied more than the other species, responds to N with maximum yields at about 150 pounds and optimum yields closer to 100 pounds N per acre. However, responses to N can be quite variable. A recent study at two sites in Tennessee evaluated response of three native grasses to N amendment over six years. Responses varied between the two study sites, something that should not surprise us given the influence of soil moisture, weather patterns and varying levels of microbial activity

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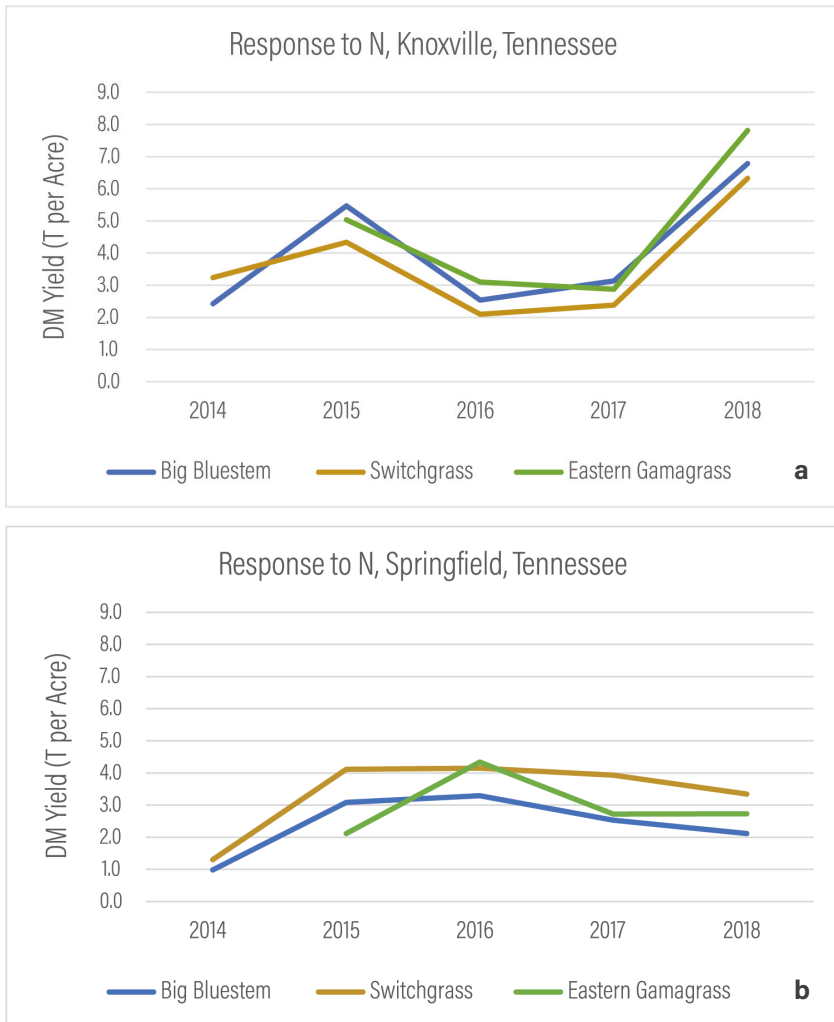


Figure 12.5. Response of three native grasses to N amendment over a six-year trial at two locations in Tennessee, Knoxville (a) and Springfield (b). Note that yields varied by both location and year. University of Tennessee, unpublished data.

among different soils. In addition, patterns varied over time with some years showing stronger or weaker responses to N but without a consistent trend (Figure 12.5). Another example comes from a study conducted on deep sands in Mississippi. In that trial, big bluestem, eastern gamagrass,

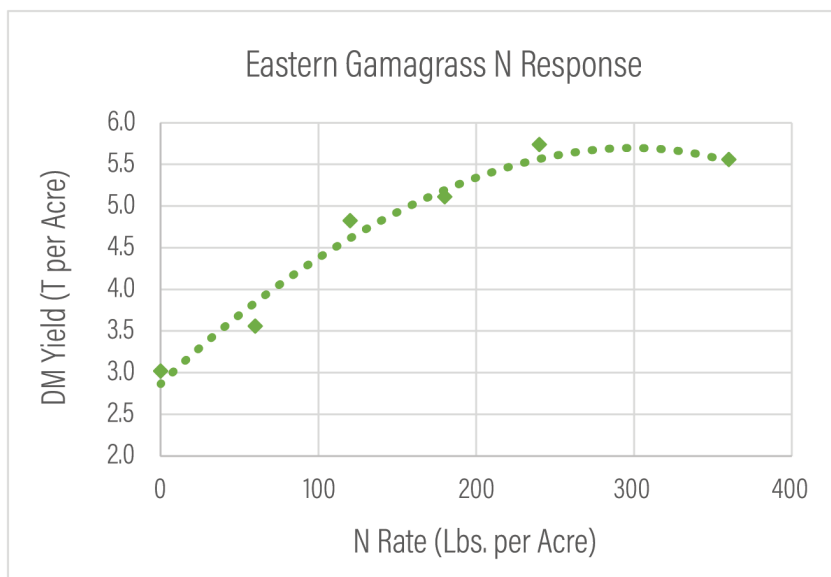


Figure 12.6. Eastern gamagrass has demonstrated a response to high N inputs as in the case of a six-year trial conducted at Knoxville, Tennessee. It appears that the inflection point was not reached until approximately 300 pounds of N per acre were applied. University of Tennessee, unpublished data.

indiangrass, little bluestem, an upland switchgrass and a lowland switchgrass all showed a positive but weak response to N; 100 pounds per acre N increased yield by less than 25 percent over soils that were not fertilized⁵⁸. And on poorly drained soils in Tennessee, N was lost due to saturated soil conditions and considerably more was needed to achieve comparable results as those observed on well-drained soils⁹.

Although not apparent in the studies just mentioned above, eastern gamagrass has demonstrated peak yields at application rates as high as 400-500 pounds N per acre. However, such high rates are never efficient economically and may have other downsides as well. Nevertheless, optimum N rates are considerably higher with eastern gamagrass than those for other native grasses. Optimums of 200-360 pounds per acre have been reported with a good target being 250 pounds per acre⁴⁹ (Figure 12.6).

Based on the data collected in the previously mentioned Tennessee trial, a consistent response to N remains apparent (Figure 12.7). In that

study, despite differences among years and between sites, overall response to N did not vary by species. These data show that a modest amount of N, 60 pounds, provides a nearly 30 percent bump in yield and an additional 60 pounds, 120 pounds total, increases yield by an additional 15 percent compared to the 60 lbs. rate. At these levels, the additional N appears to be a good choice where improved productivity is needed. Above this level though, there is little marginal improvement in yield to justify additional N (Figure 12.7). Although economic optimum has not been yet calculated on these rates, it will be less than the biological optimum.

A pattern observed with native grasses, including eastern gamagrass, is that when N is applied at rates well above the optimums mentioned above there is increased lodging and stand thinning. Although it is not understood why this occurs, it is a caution against over-fertilizing native grasses. Such high rates are not cost-effective, do not improve yield, damage the stand, encourage weeds and negatively affect water quality. Too, it is important to keep in mind that any recommendation for

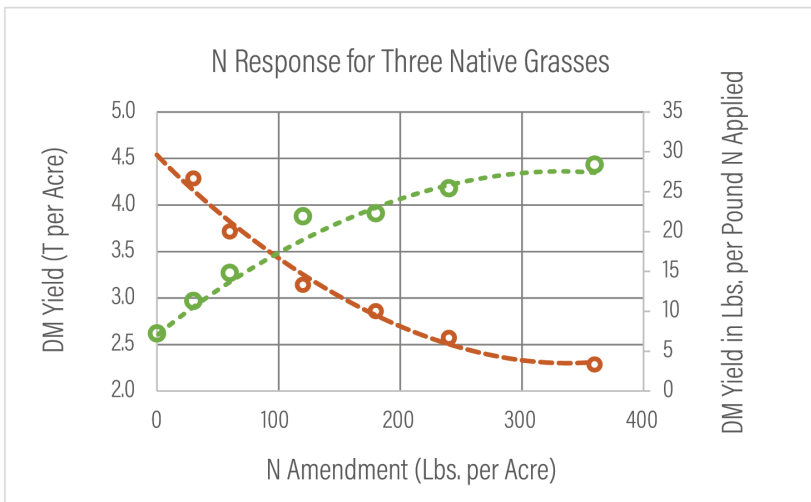


Figure 12.7. Among three species, big bluestem, eastern gamagrass and switchgrass, yield response to increased N application did not differ statistically and are therefore combined here (green line). The value of each increment in N applied (the forage yield for each pound of N applied) though, declined at an increasing rate (orange line) suggesting a threshold of approximately 120 pounds N per acre. Under an economic analysis of these data, that threshold may be somewhat lower, likely below 100 pounds per acre. University of Tennessee, unpublished data.

N fertilization must be balanced with prevailing prices for N and how critical increased production may be in your operation. In many cases, the baseline level of production without supplemental N may be all you need in a given season. Under such circumstance, there is no need for supplemental N applications.

Response to N has been shown to be at least partly synergistic with P and K and vice versa. Where P or K are quite low, response to N may be more limited. Optimum response will occur where none of the nutrients are limiting. Therefore, **always soil sample before applying lime or fertilizer**. Soil tests are cheap and there is no downside to taking them!

Soil acidity

Another well documented attribute of native grasses is **their ability to be productive on acidic soils**. This tolerance was mentioned in Chapters 1 and 7 but is worth revisiting here. Eastern gamagrass in a Missouri study grew well for more than 50 years in a claypan soil with a pH of 5.2 within the top 12 inches of soil and near 4.8 at depths of 2-5 feet. Roots of the eastern gamagrass in this study occurred extensively throughout this soil profile¹⁹. In another study, eastern gamagrass showed no yield response when soils with a pH of 5.1 were limed to a pH of 5.8²³. Within two years of establishment, the roots of these plants penetrated acidic subsoils (pH 4.8) to depths of 5 feet. In a study in Pennsylvania, big bluestem and switchgrass growing on a very acidic soil, pH 4.7 without amendment, had yield increases of about 0.5 tons per acre when amended to either pH 5.6 or 6.7, which required two and six tons per acre of lime, respectively³²! The two species responded similarly to the lime amendments.

This tolerance of acidic soils appears to apply to seedlings as well. Studies of switchgrass and eastern gamagrass seedlings have documented that growth was unaffected with pH as low as 4.4^{30; 27}. In another study in soils with pH below 4.9, switchgrass seedlings established but grew slowly³². Big bluestem can likewise be established in low pH environments³². Although the mechanisms are not understood, it is apparent that native grasses are adapted to grow and perhaps even thrive in acidic soils.

FERTILITY RECOMMENDATIONS

Based on the foregoing discussion, the basic recommendations for soil fertility for forage production with native grasses are very straightforward (Table 12.1). With respect to **P and K, amend based on soil tests whenever they are in the low category.** Enough P and K should be provided to move the soil into the medium test category. Depending on what soil lab you are using for your tests, the recommended amount will vary and may be enough to move the soil above medium. While there is no harm in these larger amounts of P and K, they are not necessary. In the case of lime, **so long as pH is at 5.0 or above, amendment is not needed.** While this level is somewhat arbitrary, it is based on the recognition that having strongly acidic soil is not beneficial. It is also based on the fact that yield responses for native grasses associated with increasing pH to the levels recommended for cool-season grasses has no apparent benefit and will not improve yield.

Table 12.1. General fertility recommendations for native grass forage production. Macronutrient recommendations are in pounds per acre. Note that with pH, response to increases above 5.0 has been limited. Consideration of lime application between 5.0–5.2 is based on improved nutrient availability and soil stewardship. With increased N amendments (i.e., 120 lbs. per acre level), increased pH may be more advisable.

Basic Recommendations for Soil Fertility for Forage Production with Native Grasses			
pH	5.0 or below	5.0–5.2	5.3 or above
Lime	amend	marginal	none
Soil test level			
	Low	Medium	High and very high
Phosphorous	80	0	0
Potassium	40	0	0
Production objective			
	Low	Moderate	High
Nitrogen	0	60	120

Finally, **N should be supplied based on your production goals.** If additional grazing days or tons of hay are not needed, do not apply N. On the other hand, up to **60 pounds per acre of N** will give the grass a considerable boost in yield and, under most circumstances, will be a good investment. **Even rates up to 100 pounds per acre may, depending on cost, still make good sense for economically efficient increases in yield.** However, with the exception of eastern gamagrass, rates above this level will likely not be cost-effective and may create some other problems including increased weed pressure. Regardless of species, it is important to remember that soil conditions can influence the effectiveness of N applications. On marginal soils, N may be less effective and application rates may need to be increased to achieve the same yield goal. Such higher rates may not be cost effective. Depending on cost of N, even standard rates may not be cost effective on such sites.

Effects on forage quality

Most studies have not linked improvements in forage nutritive values to application of P, K or lime. On the other hand, positive relationships with application of N have been documented. As mentioned in Chapter 11, modest improvements in CP (increased concentrations of about two percent) have been reported for eastern gamagrass, big bluestem and switchgrass⁵⁰. Such improvements may add to the benefits associated with increased yield by itself.

Timing fertilizer applications

Because of the growth season of native warm-season grasses, the timing of fertilizer application must differ from that for cool-season species. And although the timing is different, the principle is the same—apply when the grasses are in a position to fully take advantage of the nutrients. Given the time of spring green-up for warm-season grasses, this works out to be in late April in the Mid-South. At this point, the grasses will **have broken dormancy and begun rapid growth with canopies approximately 12 inches tall** (Figure 12.8). Earlier applications,



Figure 12.8. This mixed stand of big bluestem and indiangrass is just over 12 inches tall and is at an ideal stage for application of N. Actual date may vary by season and location, but stage of grass development is the critical consideration. The grass here is actively growing and dominating the site and will, therefore, be in a position to take full advantage of the N.

those typical of the timing for cool-season species, will be at risk of loss through heavy rains and soil leaching or even volatilization before the warm-season species are able to take advantage of the N. More importantly though, such early application will favor cool-season competitors and not the warm-season species.

On the other end of the spectrum, it is also important not to apply fertilizer too late in the growing season. **After late summer and certainly during fall, do not apply N** to native warm-season grasses. At this point in the season, the native grasses will not be able to take advantage of the fertilizer and it will only help cool-season weeds. And as is the case with other warm-season perennials, native grasses should not be fertilized even after mid-summer. With normal N rates of 60-90 pounds per acre, there is no need for split applications. In the case of eastern gamagrass where as much as 200 pounds N per acre may be applied,

application should be split with the second application occurring about two weeks following an initial harvest. Because eastern gamagrass can be grazed or hayed earlier in the season than other native grasses, the timing of this second split would be early to mid-June in the Mid-South. This is similar to the timing with bermudagrass or other warm-season perennials receiving split N applications. And as with any application of fertilizer to forages, do not apply under drought conditions.

What about replacement of nutrients?

Good soil stewardship dictates that we do not “mine” the nutrients out of our soils. With grazing, a large proportion of the nutrients are recycled within the pasture and reductions in levels of major soil nutrients may not be appreciable. However, with hay harvest, some substantial amounts of nutrients are literally removed from the hay field. For example, a harvest of mixed big bluestem/indiangrass hay at early boot stage removed 37, 12 and 49 pounds of N, P and K, respectively, per ton harvested⁴³. Assuming an annual per acre harvest of four tons and those same removal rates, you would remove 148, 48 and 196 pounds of N, P and K per acre every year. If you assume you have to replace all of that every year, pound for pound, production costs would go up considerably.

Fortunately, for all of the reasons mentioned above regarding the thrifty use of nutrients by native grasses, such replacement is not necessary. In fact, in a variety trial for big bluestem and indiagrass conducted over five years, 60 pounds of N were applied per acre per year and P and K were only amended when levels dropped into the low category per annual soil test. In other words, the recommendations provided above were followed. During that time, P and K were only applied once at 90 pounds per acre each based on this standard. This underscores the importance of soil testing but also the fact that hay harvests in native grasses do not require a 1:1 replacement to avoid soil mining and depletion of these nutrients.

SUMMARY

Native grasses are well adapted to weathered, acidic soils, where fertility levels are low. Indeed, multiple research projects have demonstrated limited response for native grass yields across a wide range of P, K and pH levels. Regardless, where levels of P and K are in the low category per soil test, they should be amended to medium. Such amendments will allow N to be more effective and will avoid depletion of soils over time. Similarly, soils testing below pH 5.0 should be limed to ensure optimum use of applied N. Despite the limited response of native grasses to P, K and lime, N application can be worthwhile. Application of 60-100 pounds N per acre is economical in most circumstances and can increase yields by 1-2 tons per acre. If additional production is not needed, leaving the stand unfertilized will not be detrimental. Timing of N fertilization is also critical and should occur in spring when the native grasses have broken dormancy and are rapidly growing. Applications in late winter/early spring or after mid-summer should be avoided and will only benefit weeds.

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CHAPTER THIRTEEN

Dormant-Season Management

Native warm-season grasses will be fully dormant by late October and do not break dormancy again until late March in the Mid-South. These dates may shift by as much as one month moving to the northern Corn Belt and two weeks in the Deep South. What can you or should you do with these dormant grasses during this period? As mentioned in Chapter 5, there are several options you should consider. The simplest option is to do nothing. However, the dormant season can also be a time for stand maintenance. There are also some options for grazing at this time including taking advantage of the “stockpile” and overseeding winter annuals. Each of these options is described in further detail in the sections below.

WINTER CARE

Once native grasses have gone dormant, there is nothing that must be done to maintain a healthy, productive stand. You can simply allow the site to remain idle. However, as described in Chapter 10, the first step in winter care of the stand is to ensure that the grasses have had some rest prior to dormancy to enable them to store the nutrients and energy they will need to overwinter. Nevertheless, the dormant period does present opportunities for improving the productivity of the stand. Because these are warm-season species, winter is a good time to address any problems with cool-season weeds, both annuals and perennials. It is also a good time to conduct prescribed burns.

Weed control

During dormancy, cool-season weeds can take advantage of the lack of competition from the warm-season perennials (Figure 13.1). The better quality the native grass stand, the less of an issue these weeds will be; dense, vigorous native grass stands provide fewer opportunities for cool-season weeds to get a foothold. Regardless, these weeds can be easily controlled in warm-season grass fields during dormancy, precisely because the native grasses are dormant. Non-selective herbicides like glyphosate can be used on dormant native grasses without injury thus allowing either grassy or broadleaf weeds to be controlled with a single application. As is the case during the growing season, broadleaf formulations can also be used during dormancy. Because control of cool-season weeds can have a substantial impact on the vigor of native grass stands (see Chapter 9), addressing them should not be overlooked. Options for dormant-season weed control are more fully addressed in Chapter 15.

Prescribed burning

Prescribed burns during the dormant season can benefit native grass pastures and hayfields (also see Chapter 9). Burning has a number of benefits for warm-season grasses including increased growth, improved



Figure 13.1. Volunteer winter annuals growing in a dormant native grass stand. Note that the annuals are most prevalent where there are thin spots within the native grasses.

Can I use a native grass pasture for a winter-feeding area?

I am often asked how well a native grass pasture is likely to hold up as a winter-feeding area or “sacrifice lot.” The answer depends on the species of native grass in question. For lowland switchgrass, so long as the stand has a relatively high plant density, the answer is yes, it can function as a good winter-feeding lot. Where the stand has suffered from winter use, it can be readily restored with judicious weed control and adequate rest (Figure 13.2). The same switchgrass pasture should not be used for winter feeding in consecutive years. However, for eastern gamagrass, because of the open nature of these stands, there is too much risk for site damage and weed encroachment. While stands of big bluestem, indian-grass or a blend of the two can develop excellent ground cover, they will not hold up as well as switchgrass under the heavy traffic of winter feeding. Thus, while they could be used as well, they should be used more sparingly than switchgrass. One caution for using any native grass stand for hay feeding is to avoid use of hays that may introduce particularly difficult to control weed species.



Figure 13.2. This 12-year-old lowland switchgrass field had been used as a winter feeding area the previous winter. Despite being quite wet that winter and the site being heavily impacted, the stand remains intact. Although weakened, the stand will easily recover with some modest rest.

forage nutritive quality and suppression of weeds. However, timing of these fires is important. Ideally, burning native grass pastures or hayfields should be timed to coincide with the first active growth of the grasses. In the Mid-South, this will occur about April 1, depending on the spring. Earlier or later burns can present some problems. Additional detail on prescribed burning is provided in Chapter 17.

FORAGE OPTIONS

The simplest option for gaining some grazing from dormant native grass pastures is to simply graze what was already there at dormancy. The quality of such forage is always marginal and will require some protein supplement. In terms of volume of forage, that is something that can be controlled by the amount of rest the stand received during the latter part of the growing season. In a recent Tennessee study, resting stands after early August left approximately 2,000 pounds per acre (dry matter basis) of stockpiled forage⁶³. With longer rest periods, a considerable amount of biomass can accumulate such that there could be a high degree of lodging or trampling loss. Animal performance on this dormant material will not be good, but it can sustain mature animals when supplemented with protein. In fact, in much of the Great Plains, such forage is the predominant source of winter feed for many herds (Figure 13.3a).

A recent study in Tennessee used yearling heifers to graze dormant switchgrass and mixed big bluestem/indiangrass stands (Figure 13.3b). In this five-year project, 7 cwt heifers were turned out for 80-90 days beginning in January at a stocking density of 500-700 pounds per acre⁴⁰. As you would expect, forage quality on the dormant grasses was poor, 3.5 percent and 4.5 percent CP for the switchgrass and big bluestem/indiangrass blend, respectively. Fiber content was high, 77 percent and 70 percent NDF for the switchgrass and big bluestem/indiangrass blend, respectively. Because of the low protein levels, heifers received 1.5 pounds per day of dried distillers grains (28 percent CP). How did these heifers fare on this diet? Those grazing dormant big bluestem/indiangrass lost,



Figure 13.3. Cattle on native grass range in the Great Plains are commonly wintered on such grasses as seen here in northwestern Nebraska (a). Although forage quality was low, cattle grazed native grasses during the dormant season for 100 days with a protein supplement in a Tennessee study (b). Credit (b), J. Richwine.

on average, 9 pounds over the period while those grazing the switch-grass lost 60 pounds. Despite these modest drops in weight, breeding, which took place two weeks after removal from the native grass pastures, was not affected by the diets with pregnancy rates remaining above 90 percent (Figure 13.4). Animals did well in part because of the supplement

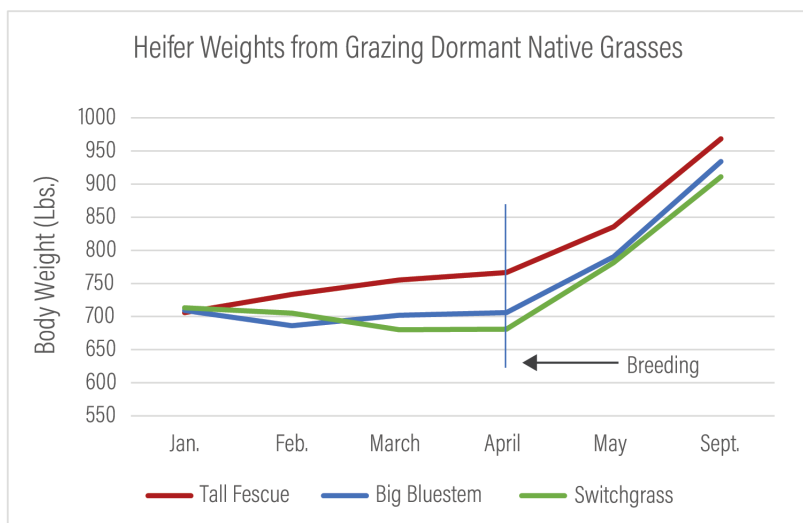


Figure 13.4. Beef heifers grazing dormant big bluestem or switchgrass January-April lost weight but, despite that, breeding success was not different from those grazing tall fescue over the same period, 90-93 percent; calving dates did not differ either. Adapted from McFarlane et al., 2018. *Journal of Animal Science* 96:4633-4643.

but also because through selective grazing of leaves at 5.1-6.5 percent CP, actual in-take protein levels would have been greater. And from a cost perspective, the dried distillers grains averaged only about \$0.12 per heifer per day. Combined with the low cost of the stockpile, this turned out to be a pretty good bargain! Thus, despite their low apparent value, using dormant native grass forages can make sense.

Volunteer winter annuals provide another option for dormant-season grazing. In most cases, the amount of forage available in fall from such volunteers will be limited. But in late winter, the amount can easily justify the movement of cattle onto the dormant grasses. Although control of these cool-season species can be accomplished as described above with herbicides or prescribed fire, use of grazing is a good alternative. And in the case of grazing, rather than costing money, it can provide several days or even weeks of grazing. The value of this grazing will be governed by the species of volunteers in question. I have often seen heavy growth of annual bluegrass in dormant native grasses. On

the other hand, I have also seen dense deadnettle or buttercup develop during late winter. Perennial cool-season species can also become established in native grass stands and they can likewise be grazed in late winter or early spring. In the Mid-South this is most likely to be tall fescue, but further north it could be orchardgrass or smooth brome.

Overseeding winter annuals

Another option for more fully utilizing native grass acreage during winter months is to overseed the field with a winter annual. This is a common practice in the Deep South with bermudagrass and can provide about 60-70 additional days of grazing. Typically, these additional days are in late winter and early spring with only limited grazing during fall. Recent studies in the Southeast have demonstrated that overseeding winter annuals can be done with native grasses as well.

In a study in Alabama, cereal rye and a rye/red clover blend were overseeded into eastern gamagrass³⁸. No negative impact on the eastern gamagrass was observed in this two-year study. The annuals produced high quality forage but volumes were very low, about one ton per acre. While grazing is the most obvious use of overseeded winter annuals, a recent study in Tennessee demonstrated that harvesting these crops for hay could also work⁶⁵. In this study, lowland switchgrass was overseeded with rye, wheat or ryegrass over two consecutive years with the cool-season annuals harvested at one of three dates, April 15, May 1 or May 15 (Figure 13.5). The annuals yielded well, 2-3 tons per acre, depending on species and harvest date, and had no negative impact on subsequent yield or vigor of the switchgrass even after two years. The mechanically harvested stands of annuals, particularly those harvested at the later dates, had heavier, taller canopies than what would be expected from a grazing scenario and, as such, would presumably have presented greater competition to the switchgrass. The later-harvested stands, those cut in May, were estimated to produce hay at a cost of \$160-180 per ton. Grazing would be a much more cost-effective way to harvest this material.

An ongoing study is evaluating overseeding rye and a rye/clover/brassica blend over three successive winters into both switchgrass and a big bluestem/indiangrass blend. Although these data are still being analyzed at the time of this writing, there are some preliminary lessons we can glean from the project at this point. First, as has been the case with the other studies on winter annuals, no negative impact on the native grasses has been observed. Secondly, as mentioned for the Alabama study, annuals here were not productive with only limited

grazing provided in two of the three years. This was due to a late planting date the first year (mid-November) and an exceptionally dry fall the second year that resulted in limited stand development for the annuals. These situations both serve to underscore the risk of annuals. Planting must be timely, September in the Mid-South, and rainfall adequate to ensure strong stand development. Prolonged winter cold spells can also reduce production by delaying spring growth. And winter annuals planted into an existing perennial grass sod tend to develop more slowly than those in prepared seedbeds. On the whole then, the cost of the winter annuals and risk of getting only limited grazing need to be considered before implementing such a program.

Although these studies have shown that overseeding can work, some caution should be taken in use of this tool. Recall that competition during the early growing season can be a serious challenge for native grasses



Figure 13.5. Winter annuals were successfully planted in dormant lowland switchgrass for two consecutive years during this Tennessee trial. Annuals produced 2-3 tons per acre. Credit, D. McIntosh.

(see Chapter 10). This is a time of year when native grasses are especially vulnerable to competition. In fact, a major part of why early season prescribed burns are so effective at enhancing growth of native grasses is that such burns eliminate weeds — and thatch — and thus allow much greater light levels to reach the plants. And this increased solar radiation comes at precisely the time of year they are most able to take advantage of that light. By contrast, the shade and cooler soil temperatures that the winter annuals promote work in exactly the opposite direction and handicap the native grasses. Thus, they may delay dormancy break, which requires further use of root reserves, shorten the effective growing season and potentially weaken the warm-season grasses. For example, in several studies examining use of cool-season legumes in native grasses, heavy growth of the legumes during early spring had a strong negative impact on the perennial grass (Figure 13.6)^{26; 34}.

To avoid any potential problems from such spring competition, there are three simple steps that can be taken. First, consideration must be given to which winter annuals to use when overseeding native grasses. **Use of annual ryegrass with native grasses is not recommended** due to its later growth season and high degree of overlap with the warm-season



Figure 13.6. Red clover, because it is a cool-season species, can develop heavy growth before warm-season grasses as seen in this big bluestem pasture in early April. Growth of the warm-season grasses was delayed and production markedly reduced by this heavy spring competition.

grasses. Annual ryegrass can also be more persistent over time, is more difficult to control and, consequently, can become a serious problem. Instead, use the cereal grains such as rye, triticale or wheat. Because cereal rye has the earliest maturity of these species, it has the advantage of a shorter period when its growth overlaps that of the native grasses.

With respect to cool-season broadleaf species, some caution is also in order. **Species with aggressive early spring growth such as crimson clover should be avoided. Similarly, species that have the ability to climb and overtop the native grasses such as hairy vetch should not be used** (Figure 13.7). Annuals such as forage radishes or turnips will not be a problem.

The second important step in preventing problems from winter annuals is proper grazing of the overseeded species. The annual should be grazed aggressively in late spring such that the canopy is removed early enough to minimize meaningful competition with the warm-season perennials. In practice, this means that **the annual should be grazed out by about April 20** in the Mid-South. That date should be adjusted based on your location and the conditions for any particular spring. For hay production, earlier cuttings are likewise advantageous. However, such early cutting can be a problem in terms of suitable weather for curing hay. Thus, putting the material up as haylage will likely be necessary.



Figure 13.7. Cool-season legumes can overwhelm dormant warm-season grasses in early spring before the grasses have broken dormancy. Although it is not apparent that these are switchgrass plots, the hairy vetch (left) and crimson clover (right) have formed dense canopies that delay the growth of the warm-season species and severely weaken the stand if not quickly removed. These species should not be interseeded into warm-season grasses.

Finally, to avoid any weakening of the native grass stand, do not overseed the same field year after year. Rather, rotate the planting to a different field or skip planting altogether some years. While winter annuals make excellent forage, like all annuals the grazing season is relatively short. Furthermore, like all annuals, the yearly establishment cost makes them an expensive forage production strategy over the long run. And this problem only gets worse where stand development is poor due to delayed planting, dry fall weather, extreme cold or other factors. All of these result in reduced grazing days or yields making the cost per unit of production greater.

SUMMARY

Winter dormancy presents several opportunities for improving native grass stands or extending the grazing season. The dormancy of the warm-season species allows for a wide range of herbicide options including non-selective products. Prescribed fire is an excellent tool that can also contribute to reduced competition and increased grass growth. Although many producers are not concerned about production during the dormant season, there are a few options that can extend the grazing season. First, the dormant stockpile can be grazed but will require a protein supplement. Volunteer cool-season species can also provide an opportunity for some grazing during the dormant season. And finally, overseeding winter annuals is an option. However, as is often the case with annuals, they may not be particularly cost effective. Although several studies have shown that the annuals can be successfully overseeded into dormant native grasses, getting a good stand requires timely seeding and favorable weather conditions. It is also important to recognize that the cool-season species could, in some circumstances, present too much competition for the perennials during spring dormancy break.

CHAPTER FOURTEEN

Economics of Native Grass Production

Economic evaluations of native grass forage production to date demonstrate that they are a cost-effective option. Below, the process for conducting these analyses is explained in simplified terms. This explanation is provided because many readers may not understand why native grasses are so cost-effective. Hopefully, these explanations will clarify the issue. As is the case with any economic evaluation of any forage, the economics of native grass forage production are based on the simple ratio of inputs to outputs, cost versus revenue. These factors have been assessed in simple spreadsheet budgets, more sophisticated economic models or from field research. Those based on field research are best but are not always available.

How we get there

Simple spreadsheet budgets, more formally known as enterprise budgets, can be very useful. For instance, using spreadsheets to compare establishment costs of two forages is a straightforward process. Based on experience and standard extension recommendations for a given grass, we can determine what the inputs should be and, for a given point in time, the costs of those inputs. Using the same cost data allows us to directly compare the two forages. Many extension services have online calculators that allow you to input costs and determine this for your own situation (e.g., agecon.ca.uky.edu/budgets).

Based on the costs provided through these simple budgets, we can then go on to assess cost per ton of hay, cost per pound of gain, break-even points and net returns per acre. However, these assessments will be on a per acre basis rather than for the whole farm. Having assessments

on a whole-farm basis would require production data from all the fields on that farm and can quickly become very complicated. For that reason, such economic assessments are not readily available. How per field investments fit the whole-farm picture must, by and large, be determined on a case-by-case basis for each producer and be guided by the conditions appropriate to that operation.

UNDERSTANDING NATIVE GRASS BUDGET INPUTS

Costs are the starting point for any economic evaluation of any forage. Establishment (typically prorated over a 10-year assumed stand life) and annual production costs are both combined to determine overall inputs. These are based on prevailing prices for seed, fertilizer, lime, herbicides and custom application and, sometimes, labor costs. Seeding rates, fertilizer inputs and steps required for control of existing competition as well as those for follow-up weed control during the seedling year are all based on best practices and experience (Table 14.1). Because of the potential for stand failure, we normally include an additional 10 percent of total estimated establishment costs to account for that risk. Because native grasses do well on marginal soils, it would rarely be necessary to factor in any lime or fertilizer during the establishment year. Thus, seed costs can make up 60-70 percent of the establishment budget for native grasses.

To reflect budgets for ongoing stand management (every year following the establishment year) similar costs are included (Table 14.2). As is the case with establishment, fertilizer or lime inputs for native grasses are generally minimal. Under most circumstances though, some N is recommended, so typically, we will include 60 pounds of actual N per acre per year (plus spreading costs) in our budgets. Although P and K are not normally needed, we often include them with an assumption of amendment once every three years at 90 pounds per acre plus spreading cost. In a grazing setting, this level of input may not be needed, but in hay production, where these nutrients

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are removed each year, some replacement is quite likely and is therefore included. Herbicide application once every two years is a reasonable assumption.

Table 14.1. A typical spreadsheet budget for native grass establishment showing inputs and associated costs. Note that the budget includes a cost for re-establishment based on a 10 percent risk of initial stand failure. Based on K. Brazil, Ph.D. dissertation, University of Tennessee, 2019.

Component	Price	Unit	Price per unit	Amount per acre	Per acre cost
Switchgrass seed	\$9.50	lbs.	\$9.50	6	\$57.00
Glyphosate (two applications, 1.5 quarts per acre each)	\$25.00	gallon	\$25.00	0.75	\$18.75
Urea (no inhibitor), 30 units N	\$364.00	ton	\$0.40	n/a	\$-
Phosphorous - DAP	\$497.00	ton	\$0.54	30	\$16.21
Potassium - potash	\$346.00	ton	\$0.29	30	\$8.65
Lime (2 T per acre)	\$25.00	ton	\$25.00	n/a	\$-
CimarronPlus (one application, 0.5 oz. per acre)	\$14.00	ounce	\$14.00	0.5	\$7.00
Custom application - fertilizer	\$8.00	acre	n/a	1	\$8.00
Custom application - lime	\$9.00	acre	n/a	n/a	\$-
Custom spraying	\$11.50	acre	n/a	3	\$34.50
Mowing	\$22.13	acre	n/a	1	\$22.13
No-till planting	\$12.00	acre	n/a	1	\$12.00
Annual land rent	\$20.00	acre	n/a	1	\$20.00
Subtotal					\$204.24
Risk of re-establishment (10%)					\$20.42
Grand Total					\$224.66
Pro-rated cost over 10 years at 6% interest					\$30.52

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Table 14.2. A typical spreadsheet budget for native grass production showing inputs and associated costs. Note that the budget includes prorated establishment costs (10-year basis). Based on K. Brazil, Ph.D. dissertation, University of Tennessee, 2019.

Item	Price	Unit	Price per unit	Amount per acre	Per acre cost
Pro-rated establishment cost	\$30.52	acre	\$30.52	1	\$30.52
Urea (no inhibitor), 30 units N	\$364.00	ton	\$0.40	51	\$20.18
Phosphorous - DAP	\$497.00	ton	\$0.54	24	\$12.96
Potassium - potash	\$346.00	ton	\$0.29	24	\$6.96
Lime (2 T per acre)	\$25.00	ton	\$25.00	0	\$-
CimarronPlus (application every two years, 0.5 oz. per acre)	\$14.00	ounce	\$14.00	0.25	\$3.50
Custom application - fertilizer	\$8.00	acre	n/a	1	\$8.00
Custom application - lime	\$9.00	acre	n/a	0	\$-
Custom spraying	\$11.50	acre	n/a	0.5	\$5.75
Annual land rent	\$20.00	acre	n/a	1	\$20.00
Total pasture expenses					\$107.87

Fixed versus variable costs

Agricultural economists may also include a number of fixed costs in a pasture or hayfield budget. Fixed costs include such expenses as land rent, equipment or other capital depreciation, interest and insurance. None of these are considered out-of-pocket or variable costs, but there is good reason to include them in a budget—they are all real costs of running any type of farming enterprise and if not accounted for will eventually create substantial cashflow problems. On the other hand, if the goal is simply comparing two forage options to each other, economists will use “partial budgeting” and assume that the fixed costs would cancel each other out regardless of which forage is selected. All of the forgoing applies to any calculation of production costs regardless of what forage is being considered, native or otherwise. The process is

identical. Input costs are also held constant among forages being evaluated, at least on a per unit basis. The only thing that changes from one forage to another is what the best practices recommendations are for the type and amount of those inputs. A good reference for all of this is "Farm Management," written by Ronald D. Kay, William M. Edwards and Patricia A. Duffy.

Three examples of pasture cost

What becomes apparent with these budget exercises is that native grasses are less expensive than many other forage options. In three recent analyses, the annualized establishment cost for native grasses were compared to other warm-season options (Table 14.3). Although each analysis included a different set of forages and some differences in assumptions, in all cases the cost of the native grass establishment was lower than the other warm-season alternatives. **Costs were lower for the native grasses because they are perennials (no annual establishment cost) or, relative to other perennials, their seed cost is lower, cost of soil amendments is lower or some combination of both.** In the case of Analysis 1 (Table 14.3), tall fescue was also included in the comparison. In this scenario, the establishment costs were only slightly greater than those for the native option. This was a result of lower tall fescue seed costs (\$28 versus \$57 per acre for switchgrass) but higher costs associated with soil amendments.

In those same three analyses, **annual operating costs were lower for the native grasses, in part because of the lower establishment costs, but also because of reduced inputs under normal management** (Table 14.3). Of course, there is no guarantee that for any particular pasture or hayfield that these numbers will turn out to be exactly correct. That is not the intent of the exercise. Rather, the goal is to compare forages on an equal footing with the most appropriate assumptions based on best practices and experience. Given this approach though, it is clear that native grasses are a low-cost alternative for forage production.

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Table 14.3. Estimated establishment and annualized pasture costs from three recent analyses. Assumptions and costs among examples varied and may not be directly comparable. Costs within examples are based on comparable assumptions.

Study	Forage	Annualized establishment (\$/acre)	Annual operating ^a (\$/acre)	Reference
Analysis 1	Switchgrass	31	106	Brazil and coworkers, 2020
	Bermudagrass (seeded)	50	211	
	Tall fescue (KY 31)/clover	35	148	
Analysis 2	Eastern gamagrass	43	64	Keyser and coworkers, 2020
	Sorghum × sudangrass hybrid	77	98	
Analysis 3	Big bluestem	21	58	Rushing and coworkers, 2020
	Native mix ^b	26	63	
	Bahiagrass (seeded)	36	74	

^a Includes annualized establishment costs.

^b Big bluestem, indiangrass, little bluestem.

UNDERSTANDING NATIVE GRASS BUDGET REVENUES

The other half of the equation for calculating economic benefits of forages are assumptions about revenues. Regardless of the forage, we normally do not assume what forage the animals have grazed will affect sale price for that animal. A pound is a pound. Similarly, for hay sales, we consider the price to be constant. A ton is a ton. Also, prevailing market prices may vary for hay and various classes of cattle, but for the sake of comparing two forages, we hold these constant as well. What is important then, is calculating what gains and yields we expect from the forages being evaluated. To do this, we look at published studies based on field research.

Hay yields

Based on the yields produced by native grasses, a simple assumption for the purposes of this discussion is that big bluestem produces four tons per acre and that eastern gamagrass produces five tons per acre (see

Chapter 3). Thus, the cost per ton is easily calculated using the annual operating cost per acre in Table 14.3 as \$14.50 ($\$58 \div 4$) for big bluestem and \$12.80 ($\$64 \div 5$) for eastern gamagrass. Of course, this is just yield divided by per acre production costs. Hay harvest costs would need to be added to each to have an accurate assessment of the real cost per ton, \$51 for big bluestem and \$49 for eastern gamagrass. These values are also the break-even price per ton. Thus, selling such hay at any value above this would result in a net profit.

Animal gain

With respect to cost of gain, we would likewise use the cost of production but rather than dividing that by tons, we would use pounds of beef produced per acre. So, in a recent field study, annual pasture cost for switchgrass was estimated at \$53 per acre and for a big bluestem/indiangrass blend, \$67 per acre³⁴. In that same study, cost of gain was calculated (based on actual gain during that study) at \$0.31 and \$0.39 per pound of gain for switchgrass and big bluestem/indiangrass blend, respectively. Gain calculations are a bit more complex than those for hay production because pounds of beef produced per acre is a function of not only stocking density, but also rate of gain (i.e., ADG) for the animals on that pasture. So, although in the study mentioned here, rate of gain for the big bluestem/indiangrass blend was greater than that for the switchgrass, the stocking density was high enough (and cost lower) for the switchgrass to offset that advantage.

Although having accurate assessments of yield per acre and gain per acre are obviously important in comparing two forage options, it is easy enough to adjust the output based on differing expectations. For example, production cost of a ton of native grass hay varied from \$48 to \$80 as yield assumptions dropped from five to three tons per acre (Figure 14.1). The same can be done with assumed gains per acre (Figure 14.2). In both cases, the costs of production can be used as break-even points to determine the value of any particular forage investment.

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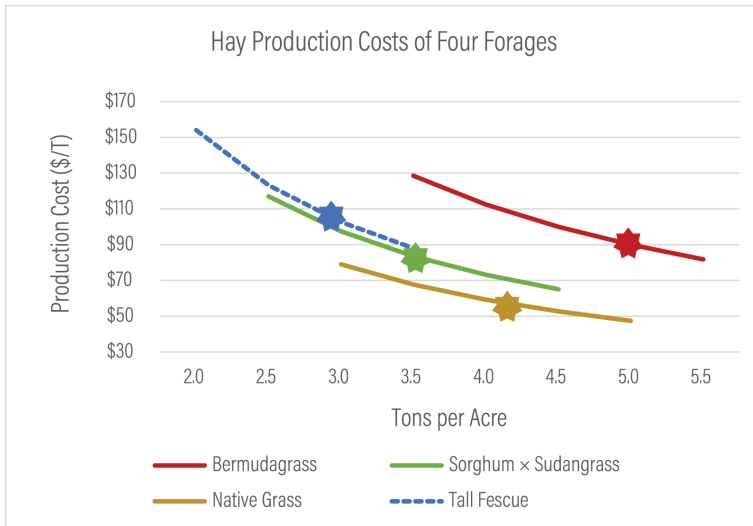


Figure 14.1. Relationship between total per acre budget expenses and annual yield (tons per acre) for four common forages used for hay production in the Mid-South. As yield increased, cost per ton produced dropped for all forages. Stars represent assumed median yield and lines represent a reasonable range of variation around those yields for each respective forage. Adapted from SP 731-E, University of Tennessee Extension Publication.

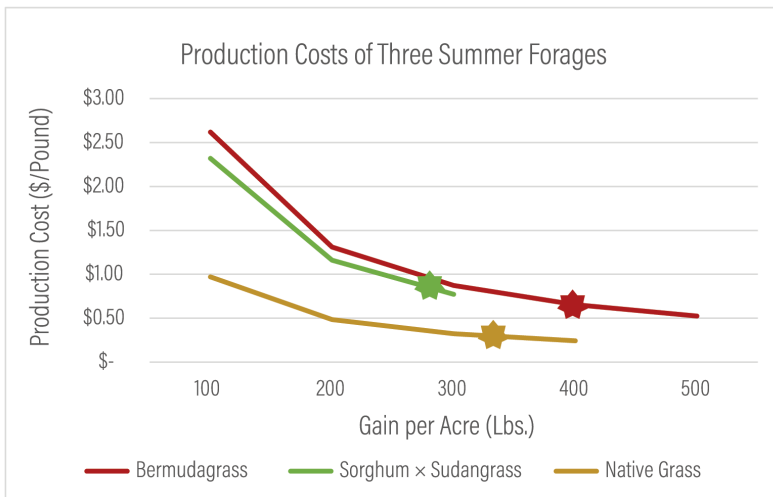


Figure 14.2. Relationship between total budget expenses and gain on a per acre basis for three summer forages used for pasture in the Mid-South. As gain per acre increased, cost per pound of gain produced dropped for all three forages. Stars represent assumed median gain per acre and lines represent a reasonable range of variation around those gains for each respective forage. Adapted from SP 731-E, University of Tennessee Extension Publication.

THE BOTTOM LINE

The takeaway for all of these analyses is simply that the break-even price (or, cost of production) for any forage will be a function of how much it costs to establish and grow and the per acre yield or gain for that forage. **Because native grasses have low costs to produce, have high yields and produce high rates of gain, they are cost-effective relative to many other forage options.** Several examples from recent studies are provided below.

Comparing break-even prices among forage options

A spreadsheet budget exercise conducted several years ago at the University of Tennessee found that the break-even price per ton of hay for four forages was \$56 for big bluestem, \$90 for bermudagrass, \$84 for a summer annual (sorghum × sudangrass), and \$112 for tall fescue, all at median yield expectations (Figure 14.1). The bermudagrass, despite greater assumed per acre yield (five tons) was more expensive than the native grasses because of greater inputs (N, K and lime). The annual was more expensive because the annual establishment cost over all ten years easily exceeded those for a single year with a perennial. Tall fescue was more expensive because, like most cool-season species, it typically produces fewer tons per acre than the warm-season species (i.e., 2.5-3.0 versus 4.0-5.0 tons) and it required more inputs than native grasses.

In a grazing situation, the budget indicated costs of gain of \$0.32 for the native grass, \$0.66 for the bermudagrass, and \$0.77 per pound for the annual. The relative costs in each case are being driven by the same factors mentioned above for hay production except that ADG comes into play. For example, the relatively lower rate of gain for bermudagrass (about 1.0 pound per day) compared to native grasses (about 2.0 pounds per day) results in a greater advantage for native grasses under grazing (+74 percent) than for hay production (+42 percent). Subsequent analyses^{34; 11; 35} based on grazing studies have confirmed these estimates (Table 14.4).

Table 14.4. Cost of gain for various warm-season forages expressed as dollars per pound of gain. Source: Brazil et al., 2020. *Agronomy Journal* 112:5067-5080; Keyser et al., 2016. *Agronomy Journal* 108:373-383; Keyser et al., 2020. *Agronomy Journal* 112:1702-1712

Forage	Animal class	Cost of gain (\$ per pound)
Big bluestem/indiangrass	Bred dairy heifers	\$0.39
	Weaned steers	\$0.31
Eastern gamagrass	Bred beef heifers	\$0.40
Switchgrass	Bred dairy heifers	\$0.31
Sorghum × sudangrass	Bred beef heifers	\$0.74

Net returns for native warm-season forages

Another way to use grazing study production data is to calculate partial net returns per acre. These returns are referred to as “partial” because some costs are considered to be constant for the producer regardless of which forage is being grown and, therefore, are not included in the analysis. In evaluating returns, there are some differing assumptions than what are made for the spreadsheet budgets. The value of a cohort of weaned calves in May at the start of the summer grazing season, the change in value per cwt of the growing calves, the change in market value in August versus May and the interest on the value of the May calves carried through the summer all are part of the calculation. Pasture cost, as was done with cost of gain analyses, are also factored into the net return assessments.

Based on this approach, the partial net return for grazing six cwt calves from May to August (108-day season) on switchgrass was \$345 per acre and for big bluestem/indiangrass \$257³⁶. For similar calves and the same two forages but with a shorter grazing season (84-86 days) and more mature swards (i.e., having gotten “behind the forage”), both as a result of management, net returns were \$104 for switchgrass and \$136 for big bluestem/indiangrass. In this case, differences in management resulted in a reduction of \$241 for switchgrass and \$121 for big bluestem/indiangrass in per acre profit (Figure 14.3).



Figure 14.3. A tale of two switchgrasses. Overmature stands (a) produce lower gains compared to those that are maintained in a high quality, vegetative condition (b).

Some lessons from net returns

There are two very important lessons in these returns. First, all the net returns were positive — and that despite reduced value per cwt (from larger size classes, about 850 versus 600 pounds, and softer markets during August than May), paying interest on carrying the calves, plus pasture cost — meaning a producer would realize greater profits by grazing the native grasses through August than selling the calves in May. Secondly, management matters. Reductions in net returns were 47 percent and 70 percent for the two forages, respectively — more than \$180 per acre in foregone income averaged between both forages. This also emphasizes the basic point made above about pasture costs and gain — the numerator (cost) in the cost/pound calculation does not change. Put another way, **it costs you just as much to have a poorly managed pasture as it does to have one that is well managed.** Conversely, management exerts a great deal of influence on the denominator and, in turn, your profitability (Figure 14.4).

Another study, one comparing five summer forage options, calculated partial net returns per acre of \$174 for switchgrass, \$100 for big

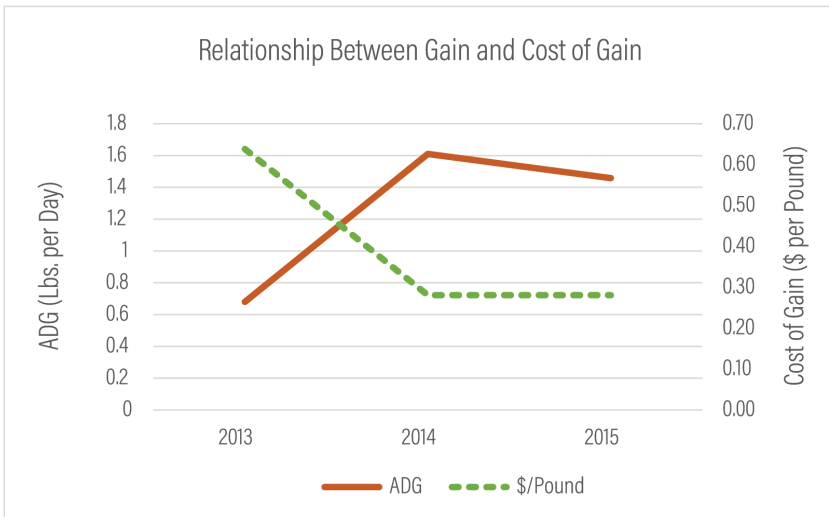


Figure 14.4. Relationship between average daily gain (ADG) and cost of gain (\$ per pound) for heifers grazing eastern gamagrass over three summers. Pasture cost does not change regardless of rate of gain, which is strongly influenced by management. In 2013, ADG was low and, thus, cost of gain was high. In the two subsequent years, gains improved through better management and as a result, cost of gain dropped by more than one-half. Adapted from Keyser et al., 2020. *Agronomy Journal* 112:1-11.

bluestem/indiangrass, \$115 for eastern gamagrass, \$45 for bermudagrass, and \$1 for a summer annual¹⁰. Although the magnitude of the returns in this study was lower than in the previously mentioned project, the ranking of the outcomes is the same: native grasses provided greater returns than bermudagrass which provided greater returns than an annually planted species. This project also calculated the risk of each forage option, in this case, how reliable production was over time. Due to its limited variability in annual production across all experimental pastures (three years, six pastures per year, 18 observations total), switchgrass proved to be most reliable followed by big bluestem/indiangrass (Figure 14.5). The summer annual, due to variability in stand quality and timing of stand development (related to seeding date and/or precipitation), was easily the worst in terms of producing reliable net returns.

This study of these five forage options teaches us several lessons. First, low input grasses able to support high stocking density (i.e.,

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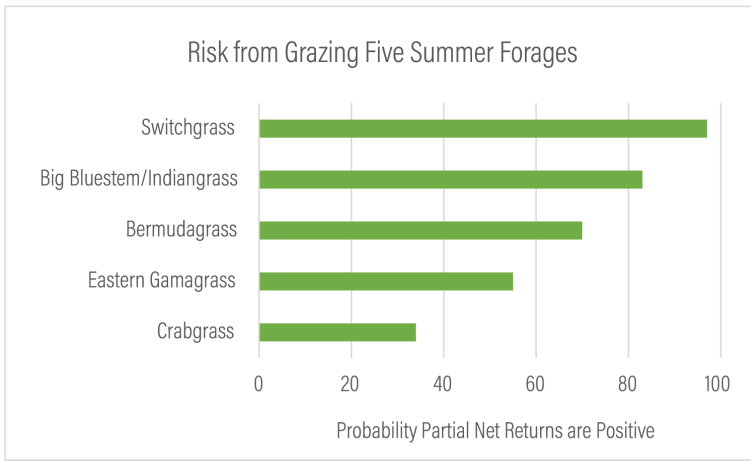


Figure 14.5. Probability of partial net returns being positive for a lowland switchgrass, big bluestem/indiangrass blend, an improved bermudagrass, eastern gamagrass, and improved crabgrass. Risk probability is based on variations of pasture productivity during a three-year grazing trial conducted at two locations in Tennessee and steer market fluctuations over time. Source: Boyer et al., 2020. *Agronomy Journal* 112:301-308.

switchgrass) are more profitable than low input grasses that have either notably lower stocking densities (i.e., big bluestem/indiangrass) or those with similar stocking densities but weaker animal performance (i.e., eastern gamagrass). Second, low input grasses will outperform higher input species, despite high stocking densities, especially when animal performance is considerably lower (i.e., bermudagrass). In fact, a study in Mississippi found that ADG was more important in determining rate of return than many other factors (e.g., seed cost, fertilizer cost) and for each 10 percent improvement in ADG, net returns also increased by about 10 percent⁴⁴. Finally, **perennials will almost always outperform annuals because annuals cost more to grow** (mainly due to annual establishment expenses) and have greater variability in productivity.

Payback periods for establishing native grasses

Given the cost of establishment of native grasses, a reasonable question might be, “What is the payback period? When will I break-even on my investment?” Although the actual payback period will vary for any

operation and any establishment project, spreadsheet budgets do allow us to take a stab at calculating when this is likely to occur. As with any evaluation, some assumptions are needed. Establishment and operational costs developed previously for a big bluestem/indiangrass blend were used to identify cost of hay production (\$53 per ton). Hay value was assumed to be \$65 per ton. No production was assumed for the establishment year (zero tons), two tons per acre for the second year of the stand and four tons each year thereafter. Based on these assumptions, years one and two produced losses, year three was near break-even, and from year four on revenues were positive (Figure 14.6). Thus, break-even can be assumed to be in three years.

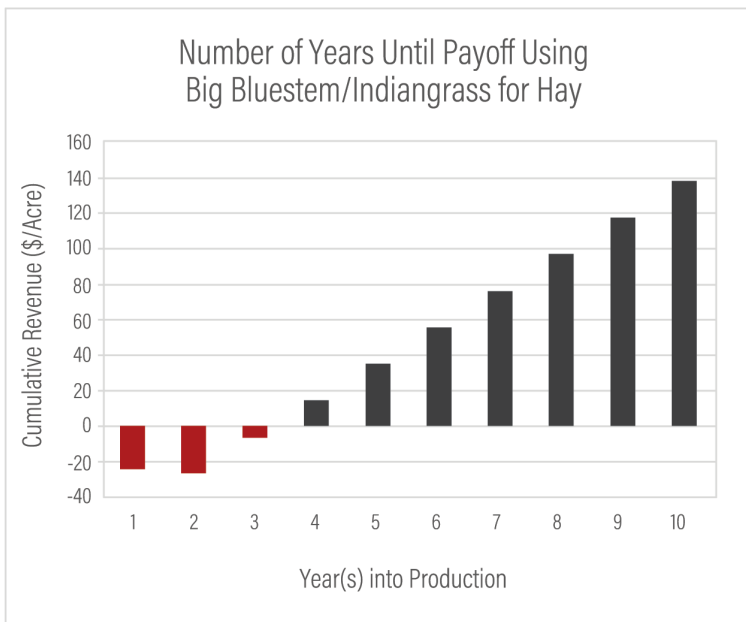


Figure 14.6. Assuming limited P and K inputs during establishment and production (30 units per acre each) and 60 pounds N applied annually during production, the payback period for establishing big bluestem/indiangrass was three years at a hay value of \$65 per ton. Yield assumptions in this scenario included hay production of zero tons per acre during establishment year, two tons per acre during year two, and four tons per acre in year three and beyond. Establishment has been prorated over the 10-year production horizon. Year two has a lower net revenue because it included annual production costs and reduced yield. With lower establishment costs and annual costs of production, big bluestem/indiangrass could become profitable a year sooner. Adapted from SP 731-E, University of Tennessee Extension Publication.

The spreadsheet budget used for this analysis assumed an establishment cost of \$225 per acre, which included inputs of 30 units each P and K (all years, including planting), 60 units N for years two and following, five quarts glyphosate and four ounces imazapic. If costs were higher, for instance, greater fertilization inputs were used, cost of production would go up and net annual revenues would decrease leading to a longer payback period. Similarly, greater input costs (i.e., more expensive N, P or K) or lower hay value would extend this period. On the other hand, reduced inputs, reduced input costs or more valuable hay could shorten the period. Finally, use of existing cost-share programs through the USDA such as EQIP (see sidebar), could markedly reduce the payback period by off-setting most or, in some circumstances, all of the establishment cost.

WHAT ABOUT THE WHOLE FARM?

As the preceding sections demonstrate, the economic implications of native grass forages at the individual field level are well established. What is much more poorly understood though is how incorporating a native grass component into the overall forage program impacts the entire operation. It has long been presumed that having better summer forage will have a ripple effect throughout the entire operation. For example, having a warm-season option will allow tall fescue to be rested during summer, leading to more effective stockpiling and, therefore, less hay feeding. Consequently, costs should decrease and net revenues increase. However, proving this at the whole-farm level, and proving that the pattern is reliable from farm to farm, is not easy. Thus, data on this question are limited and we need to rely on inference from other sources.

The Standard Performance Analysis program

One interesting data set that gives us insight into whole-farm economics is the Standard Performance Analysis (SPA). This program was developed by the National Cattlemen's Beef Association to help producers

USDA cost-share programs

One option that could lower establishment costs and, therefore, shorten the payback period, is to take advantage of USDA cost-share programs. Perhaps the most applicable is the Environmental Quality Incentives Program (EQIP) administered by the Natural Resources Conservation Service (NRCS). The program provides both technical assistance and cost-share to farmers to implement improved production and conservation practices on their land. One option producers can sign up for is the Pasture and Hay Planting (practice 512) that provides cost share for establishing native grass forages. The actual amount of financial assistance provided has varied through the years and is periodically adjusted based on prevailing market costs for seed and other materials required for establishment. Contracts are typically for three years with production allowed during year three. Some reduced production is provided for in year two under many contracts. New and limited resource farmers can qualify for a slightly higher cost-share.

Although EQIP sign-up is continuous (you can apply at any time during the year), ranking of applications only occurs once per year, typically during winter. Applications are ranked based on pre-determined criteria with higher ranked applications funded until money runs out. Those that are funded then work with their local NRCS office to develop a contract for completing the work and scheduling payments. If you are interested in exploring EQIP, contact your county NRCS office. Off-setting the cost of establishment, including fore-gone forage production during the transition period, can help make developing improved forages on your farm much easier — and save you money in the long run.

evaluate their operations and improve cost-efficiency. In one comprehensive analysis of these data from the Southern Plains (Texas, Oklahoma and New Mexico) involving 475 operations over 15 years, some interesting results emerged. Although the analysis did not address the impact of native versus non-native or cool- versus warm-season grasses, the very clear message was that grass matters! **The primary driver of profitability was the amount of pasture per cow** (Figure 14.7). Those producers that allocated more acres per cow (i.e., more conservative, more risk averse) were more profitable than their neighbors who allowed fewer acres per cow (more aggressive, less risk averse).

Agricultural economists at Texas A&M University divided the 475 operations into quartiles based on profitability. The most profitable operations — those allowing the most acres per cow — experienced a 6.6 percent return on assets. While still profitable, those that allowed 95 percent as many acres per cow as the top group saw returns of only 2.3

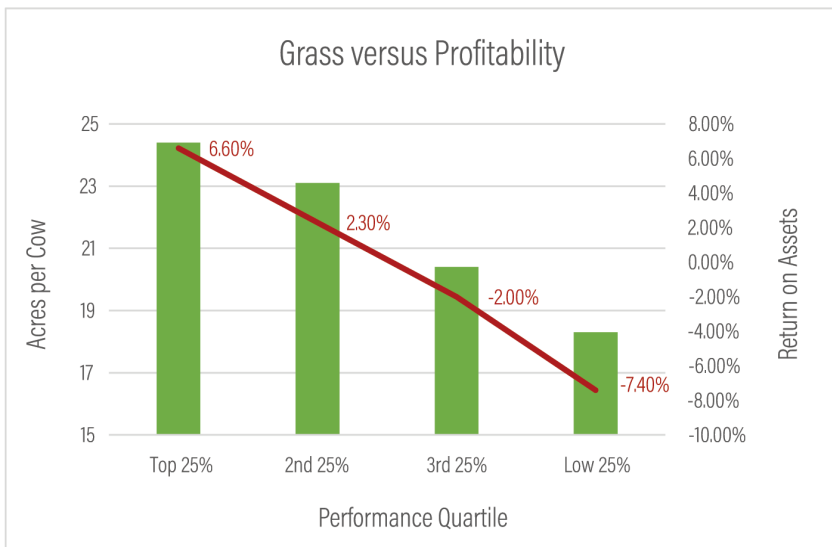


Figure 14.7. Standard Performance Analysis data showing relationship between enterprise performance as measured by return on assets and stocking rate (acres per cow). Courtesy J. Johnson, Texas AgriLife Extension.

But what about during winter? It doesn't look like this grass is making me any money then.

Producers often wonder how native warm-season grasses can be a good investment when there is a five-month window — November through March — when they are not growing at all. Although there are ways to make those acres work for you during the dormant-season (see Chapter 13), many growers I have spoken to do not see this dormant period for native grasses as a big problem. For these growers, the benefits during summer, during drought and the positive impact on their cool-season grasses are more than enough to justify having the warm-season native grasses in their forage program. For these reasons, they are not concerned about productivity during the dormant season. But if you are concerned, how much does it really matter?

One way to look at this is to assume you have had a “year-round” pasture. And let’s use a generous assumption for net return per acre of \$300. Suppose that the price of soybeans spiked and you killed the pasture and grew soybeans on that land. And suppose that your net return from these soybeans, because of the price spike, was \$800 per acre. You are still \$500 per acre ahead growing the beans, even though with soybean production the field will still be idle all winter. Therefore, even though you are using it fewer months growing the soybeans than you had as a pasture, it is still a profitable venture, more so than its previous use. And although double cropping may increase revenue from that ground, the advantage of that choice will not be the revenue it produces, but the net return, the profits. So it is with native grasses. If they increase the overall return to your operation, it may not matter that they are dormant during that period. And also recall, for a part of that six-month dormant period, cool-season species would also be dormant and, therefore, unproductive. So really, there are only three “lost” months. What you are really losing during this period is opportunity and not necessarily profit.

percent over the 15-year period. The lowest performing quartile (-7.4 percent return, a gap of 14 percent between this group and the top quartile) allowed only 75 percent as much pasture per cow and those that allowed 84 percent as much pasture as the top quartile, a -2.0 percent return. Thus, dropping from the top group, reductions of as little as five percent in pasture acres per cow had a substantial impact on profitability, while larger drops, 16-25 percent, put the operations into the red. Conclusion? More grass adds up to a more profitable operation. It seems reasonable to conclude that those with less grass did not suffer during spring or rainy periods, but rather when conditions such as drought reduced grass productivity. During a particularly tough spell, say a hard drought, which operations would be most likely to be forced out of business: those that are profitable or those that have been consistently losing money?

In an unrelated analysis, researchers at the University of Tennessee compared the cost of dairy heifer development using native grass pastures with diets based on corn silage (with distillers grain or soybean meal) that provided the same rate of gain as the grasses³⁷. As you might expect, the grass was a much lower cost alternative (Figure 14.8). Once again, the lesson is that grazing is a better economic option than other feedstuffs. University of Arkansas Extension has promoted a 300-day grazing program in recent years. Why? Grazing is preferable (lower cost) than either purchasing feed, growing silage or feeding hay. And maintaining acceptable gains on that grass is also important, as demonstrated by the Mississippi study, cited above (see, “Some lessons from net returns”), where returns were proportional to ADG⁴⁴.

Some might think that because the SPA data presented above is from Oklahoma and Texas, a very different world than the eastern U.S., it probably does not apply. True enough, it is a different part of the world. But a similar analysis from SPA data, except collected from operations in the Upper Midwest, reinforces the message, albeit in a slightly different way. Iowa State University’s Beef Center analysis determined which factors drive profitability in beef operations. Answer? Cost — much more so than production or marketing. So, as mentioned above, **it’s the numerator**,

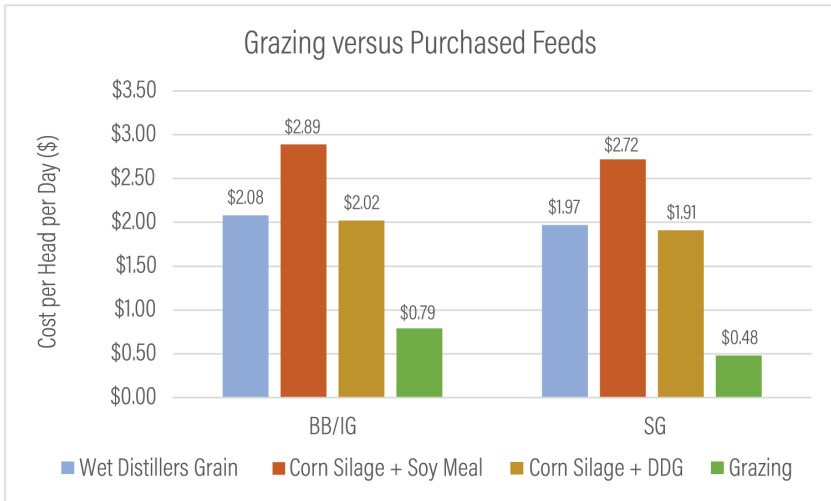


Figure 14.8. Cost to develop dairy heifers based on grazing big bluestem/indiangrass (BB/IG) and switchgrass (SG) compared to alternative rations based on distillers grains and corn silage diets that achieve comparable rates of gain for 10 cwt animals. Source: Lowe et al., 2015. *Journal of Dairy Science* 99:634-643.

the cost of production that is driving profitability. A steer that sells for \$1.40 per pound brings that same price for the producer whether it costs \$0.40 or \$1.20 per pound to produce. And which cost component was most important to profitability? **Feed cost**, which **explained 57 percent of the variation in profitability among operations.** The next closest factor? Depreciation, way down at nine percent. Where this really showed up was the cost of non-pasture feeds with the high-cost operations spending more than three times as much on feed (Table 14.5).

It seems safe to conclude then, **that staying on grass, avoiding stored or purchased feeds and maintaining respectable gains throughout the grazing period will all contribute to positive economic outcomes.** Too, being able to sustain such gains in the face of drought (again, avoiding stored or purchased feeds) is important. While none of this completely answers the question about how native warm-season forages impact whole-farm economic outcomes, the application of these principles certainly leads to the conclusion that the outcomes are likely to be positive.

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Table 14.5. Costs and productivity from Upper Midwest beef operations based on Standard Performance Analysis data. Operations are divided into three categories (High, Average and Low) based on operational costs. Source: Iowa State University, Iowa Beef Center.

	High	Average	Low
Stored feed cost	\$507	\$306	\$159
Pasture cost	\$106	\$117	\$123
Cost per CWT produced	\$47	\$72	\$360
Lbs. weaned per exposed cow	421	401	360

A modeling approach

Another way to address the question of whole-farm profitability is to use economic models. This approach has its shortcomings, but it does at least allow us to see what the impact of warm-season perennials *could* be on a whole farm. It allows us to test some assumptions and begin to close in on the correct answer.

With that in mind, an analysis was conducted by researchers at the University of Tennessee¹¹. They developed a model to compare a conventional forage base that relied on tall fescue-dominated pastures only and two alternatives that included a 30 percent warm-season grass component, either bermudagrass or switchgrass. Annual pasture costs were calculated assuming all forages had to be established, only the warm-season grasses had to be established (no establishment cost for tall fescue) and only the switchgrass had to be established (no establishment cost for tall fescue or bermudagrass). In addition, calving rates, weaning weights, hay prices and sale prices for calves and cull cows were included in the model. Also, long-term weather patterns were factored in as an attempt to accommodate the influence of drought cycles. All of these inputs were used to calculate net present value for a 10-year horizon for spring- as well as fall-calving herds. Net present value is simply the difference in returns and costs for some future period (10 years in this case), all discounted to the present.

What this exercise showed was that, for spring herds, there was a clear advantage to having a 30 percent warm-season grass component in

the forage system. The advantage always favored the lower cost switchgrass over bermudagrass (Figure 14.9). These patterns held up (although the magnitude of the benefit declined) regardless of assumptions regarding establishment costs for the three forages. Put another way, based on this model, incorporating low-cost native grasses would make sense even if existing pastures were already in place and had to be converted to the native species. With fall herds, the advantage of including the warm-season grasses diminished and, in the case of bermudagrass, disappeared altogether. Part of what drove this outcome were the assumptions regarding the penalty of reduced calf crops with toxic tall fescue for spring (82 percent calving rate) but not fall herds (93 percent calving rate). A subsequent sensitivity analysis confirmed this pattern with net present values increasing in proportion to calving rate (Figure 14.10).

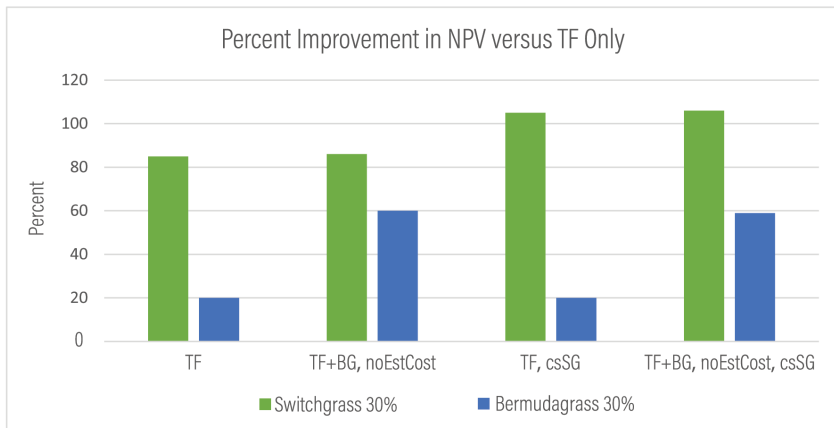


Figure 14.9. Comparison of net present value (NPV) for simulated operations with 30 percent of forage base converted to either switchgrass or bermudagrass to those with 100 percent tall fescue-dominated pastures only. All four scenarios assume tall fescue is already in place (no establishment costs included) and those indicated by 'BG, noEstCost' assume that the bermudagrass is already in place and have no establishment costs included. Scenarios with 'csSG' assume a cost-share for switchgrass establishment. Simulations are for spring-calving herds. K. Brazil, Ph.D. dissertation, University of Tennessee, 2019.

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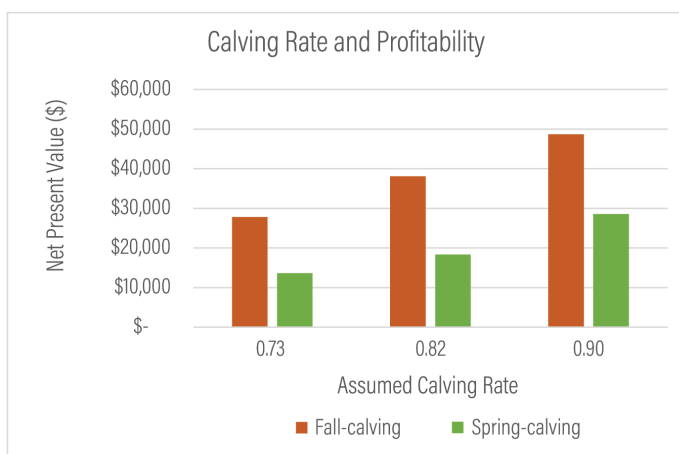


Figure 14.10. Influence of calving rate on net present value for spring- and fall-calving herds. Results are based on simulations using the same model as presented in Figure 14.9. K. Brazil, Ph.D. dissertation, University of Tennessee, 2019.

SUMMARY

Actual economic outcomes from incorporating native warm-season grasses into your forage program will be as varied as are the operations across the eastern U.S. However, there are a few conclusions we can draw that will likely apply to any operation. Because of their low input requirements—despite high seed costs and lost production during the seedling year—native grasses, acre for acre, are less expensive to grow than most other alternatives. Because of their high productivity (hay yield, high stocking densities and rates of gain), cost per ton of hay and cost per pound of gain are also lower than for most other alternatives. Rates of return, though sensitive to management, are preferable with native grasses to those from summer annuals (at least those that have to be replanted either annually or even once every several years) or bermudagrass. For whole-farm evaluations, few data are available. However, considering the value of extended grazing seasons, reduced reliance on hay or purchased feeds, reduced drought risk, sustaining higher rates of gain and the prospects for improved management of cool-season forages, it seems apparent that the incorporation of native grasses will benefit the bottom line.

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