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VIRGINIA TECH

CREEP-GRAZING WINTER ANNUALS FOR FALL CALVES

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Introduction

Previous work at the Shenandoah Valley Agricultural Research and Extension Center (SVAREC) in a spring-calving system has indicated an increase in weaning weights when calves are provided continual access to alfalfa and endophyte-free tall fescue pasture through a creep-grazing technique. However, this system is not well-suited to fall-calving herds, where calves are suckling on cows at a time when alfalfa has largely completed its growing cycle for the year.

Alternative forage species that may be well suited to creep grazing for fall-born calves are forage brassicas and small grains. These species can produce large amounts of very nutritious forage in only 45-60 days.

We have just completed a three-year project at the SVAREC funded by the Virginia Cattle Industry Board. During this time, we overseeded winter annual forages in late summer for creep-grazing by fall-born calves through the spring prior to weaning. In this study, we compared calf performance and system profitability of this practice compared to traditional rotational stocking with no creep-grazing and continuous stocking with calf creep-access to cool season perennial pastures.

Methodology

The three treatments that we included in this project included:

- System 1: pastures rotationally stocked, toxic endophyte-infected tall fescue
- System 2: pastures continuously stocked, toxic endophyte-infected tall fescue; cow pasture access restricted in winter during hay feeding, but calves can still access entire pasture area by passing underneath electric polywire
- System 3: pastures rotationally stocked, toxic endophyte-infected tall fescue with one paddock which is seeded with winter annual forages for calf creep-grazing and summer annuals for cow grazing

Each experimental unit (16 acres) was stocked with eight cows, and treatment systems 2 and 3 were replicated three times while treatment system 1 was replicated twice in the first year and three times in year two and three. Treatment system 3 was sprayed with glyphosate (2 qt/ac + 0.5% surfactant) in October in 2020, September in 2021, and October 2022. Creep forage (variety-not-stated rye at 70 lb/ac and rape cv. ‘Barsica’ at 3 lb/ac) was established in the winter annual pastures between September 24 – October 5, 2020. The creep forage seed mixture in 2021 and 2022 consisted of 50 lb/ac oats cv. 'Reeves,' 70 lb/ac triticale cv. 'Surge,' 3 lb/ac rape cv. 'Barsica,' and 15 lb/ac crimson clover cv. 'Dixie.' Nitrogen fertilizer was spread on the native grass and winter annual pastures on October 1, 2020 (80 lb/ac), September 14, 2021 (60 lb/ac), and March 9, 2023 (60 lb/ac). Calves were provided access to creep forage in the winter annual pastures on April 8 in 2021, April 1 in 2022, and April 13 in 2023. Calves in the continuous stocking treatment occasionally would graze cool season perennial forage by slipping under the single strand of electric wire around the hay feeding area in these treatment pastures. Following weaning in all three years, the cows grazed the paddocks with winter annuals in treatment system 3 following weaning. A brown-midrib sorghum-sudangrass hybrid was then established and fertilized in these paddocks after the winter annual forage was sprayed.

Figure 1. Cows at the Shenandoah Valley AREC eating hay while their calves creep-graze cereal rye forage (background).

Calves were weaned from dams on May 4 in 2021, April 20 in 2022, and April 19 in 2023 using a fenceline weaning method. Calves in the winter annual treatments were provided access to their creep-graze paddocks in addition to another cool season grass paddock to ensure sufficient forage supply during weaning. Calves in the rotational stocking and continuous stocking treatments were given access to cool season grass paddocks. Calves were removed from the paddocks 16, 14, and 13 days later in 2021, 2022, and 2023, respectively, and re-weighed.

Calf weaning weights were adjusted to 205-day age adjusted weaning weights (AdjWW) using the American Angus Association dam age adjustment factors. For this analysis, we calculated 205-day age adjusted weaning weights using the weaning weight collected when calves were removed from weaning paddocks (around two weeks after removing from the dam). Results are reported as means across both years due to no treatment by year interaction.

The weight of hay fed to each herd was summed to determine as-fed hay consumption for each treatment. Some of the herds had leftover forage in pastures during breeding when all herds were grouped for breeding. This forage was utilized then by the entire herd composed of multiple experimental herds. To account for this "leftover" forage, the total days the collective herd was stocked on the given paddock was multiplied by the number of cattle stocked on the paddock as well as the presumed weight of the cattle (1300 lb) and the presumed daily dry matter intake of the cow/calf pairs as a percentage of body weight (3.5%). This forage estimation was then subtracted from the hay consumption of each experimental unit system providing the forage and added to the hay consumption of each experimental unit utilizing the forage to calculate a net hay consumption.

Using a partial budget analysis created from the costs incurred by implementing each treatment, we compared the relative profitability of the annual forage treatment and the continuous stocking treatment to the control treatment (rotational stocking).

We used the VDACS 10-year average prices for steers and heifers by weight class to determine the change in gross returns to calf sales using AdjWW. With no statistical difference in amount of hay fed per treatment, no changes in hay consumption costs were included in the analysis. Despite no year by treatment interaction for calf AdjWW, annual changes in calf sales were calculated using the AdjWW for each treatment by year instead of using mean AdjWW across three years.

Results and discussion

The AdjWW of calves in the rotational stocking treatment (463 ± 8 lb) were significantly less ($P \leq 0.0069$) than the AdjWW of calves in the continuous stocking treatment (497 ± 7 lb) and winter annual treatment (500 ± 7 lb). There was no significant difference in AdjWW of the calves in the latter two treatments ($P=0.9836$).

Mean weight of hay fed annually to the annual forage treatment (28,498 ± 3,012 lb) tended to exceed ($P=0.0565$) the mean weight of hay fed annually to the rotational stocking treatment (17,549 ± 3,230 lb), but did not differ ($P=0.1657$) from the mean weight of hay fed annually to the continuous stocking treatment (20,402 ± 3,012 lb). There was no significant difference in hay fed annually between the rotational stocking and the continuous stocking treatments ($P=0.7968$). The creep-grazing forage provided to the calves prior to weaning exceeded 14% crude protein and 62% total digestible nutrients (Table 1).

Table 1. Forage availability and nutritive value of forage in the creep-grazing paddocks (presented as means and standard errors).

Year	Dry Matter Availability (lb/ac)	Crude Protein (%)	Total Digestible Nutrients (%)
2021	1,470 ± 70	16.5 ± 0.7	65.9 ± 1.0
2022	1,850 ± 80	19.4 ± 1.0	62.9 ± 1.2
2023	3,530 ± 220	14.8 ± 1.0	67.4 ± 0.6

The significant cost of establishing the summer annuals eliminated the benefit of the increased AdjWW of the calves from that treatment (Table 2). Increasing costs of glyphosate and fertilizer in year two and three have further negated any improvements to weaning weight from the creep-grazing treatments.

Table 2. Relative profitability of creep-grazing treatments for fall-born calving systems using a partial budget analysis (all numbers reported as relative difference in dollars per cow-calf pair compared to rotational stocking treatment)

Treatment	***Continuous stocking***			***Winter creep and summer annuals***		
	Year 1	*Year 2*	*Year 3*	*Year 1*	*Year 2*	*Year 3*
Variable costs for establishing winter annual forages	$0	$0	$0	$96.42	$166.53	$204.66
Variable costs for establishing summer annual forages	$0	$0	$0	$164.23	$193.13	$209.91
Net change in hay consumption cost	$0	$0	$0	$0	$0	$0
Net change in calf sales	$82.26	$26.73	$27.17	$80.93	$17.61	$15.98
Net annual profitability	$82.26	$26.73	$27.17	-$179.72	-$342.05	-$398.59

Conclusions

Even though we were only able to provide creep-forage to the calves for about 30 days prior to weaning, we still saw an improvement in AdjWW of around 37 lb compared to the rotational stocking treatment. However, the expense of seed and fertilizer eliminated any financial benefit to establishing annual forages for creep-grazing. The economic implications may vary depending on the value that each farmer may place on an additional 37 lb gain at weaning for their steer or heifer calves, but this study indicates that for calves valued at historical VDACS-reported prices, utilizing annual forages for creep-grazing fall born calves is not profitable.

Acknowledgements

This work was supported through a grant funded by the Virginia Cattle Industry Board.

RENOVATING PASTURES TO NOVEL ENDOPHYTE TALL FESCUE

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Fescue toxicosis – what it is and how it costs you

The fungal endophyte

Producers and conservation specialists have made tall fescue the primary forage in Virginia largely, because it is highly productive over much of the growing season and it is relatively easy to manage. Tall fescue is resilient and a strong competitor in pastures largely because of a fungal endophyte – that is, a fungus that lives within the plant.

- About 2/3 of Virginia's fescue pastures are highly (>65%) infected with endophyte.
- The fungal endophyte makes the plant resilient to stress, helping fescue survive drought, limited soil nutrients, and overgrazing.
- The endophyte gives the plant a competitive advantage so it generally outcompetes other forages in such limiting situations.

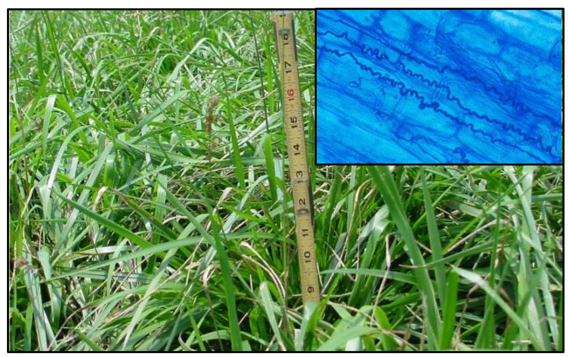

Figure 1. In this image of a stained leaf, the endophyte (inset) is visible as dark blue, squiggly lines.

Alkaloids

Fescue's agronomic benefits come with a cost to producers, because the fungus produces toxins that harm livestock. Ergovaline, the primary toxin produced by the fungus, causes many negative symptoms in cattle, including:

- Reduced forage intake
- Rough hair coats
- Reduced milk production
- Potential damage to or loss of feet, ear tips, and tail switches during cold weather
- Reduced reproductive success
- Increased core body temperature

The stress associated with increased body temperatures in turn lead to the use (and degradation) of streams and surface waters for cooling.

Animal and environmental impacts

When cattle consume alkaloids, blood vessels constrict. This reduces blood flow to extremities and increases core body temperatures. Alkaloid consumption also reduces ability to shed hair, and the rough hair coats worsen the effects of heat. In summer, the added heat stress for livestock grazing infected pastures results in their wanting to go to surface waters to cool down. In winter, reduced blood flow to the extremities can result in frost bite of tail switches and ear tips, and feet can be damaged – a condition called fescue foot.

Figure 2. Images showing various symptoms of cattle suffering from fescue toxicosis (Photos from John Fike (top left), Matt Poore (top right), Morgan Paulette (bottom right) and Dr. Terry Swecker (bottom left)).

The bottom line

The estimated cost of fescue toxicosis across the U.S. is over $1 billion dollars annually. Reduced weight gain and poor reproductive performance are primary drivers of the loss in this estimate. However, this calculation does not count the cost of damage to the environment in terms of lowered stream health, degraded water quality or the cost of remedial stream exclusion fencing.

Opportunities exist to improve animal and environmental health by renovating infected fescue pastures. Assistance is available to remove toxic fescue and convert to fescue with non-toxic endophytes or native grasses. This can be part of a whole farm strategy for mitigating fescue toxicosis. Contact your local extension office to learn more about toxicosis management strategies. Contact your local NRCS office to learn more about opportunities for fescue conversion assistance.

Converting from wildtype to novel tall fescue

Tall fescue

Tall fescue is the predominant forage in the upper South, largely because it is well-adapted to the region's soils and climatic conditions, it tolerates drought, is competitive, and persists under a wide range of management. This largely is due to association with a fungal endophyte (a fungus living within the plant).

Wildtype versus novel endophytes

Endophytes support tall fescue growth and persistence, but the common, 'wildtype' strain found in 'KY31' tall fescue produces toxic alkaloids that harm livestock (Figure 3). Once this was realized as a problem, scientists removed the endophyte and promoted "endophyte-free" fescue - but it did not persist. The newest technology has been to create the best of both worlds. Novel, non-toxic endophytes have been discovered and combined with tall fescue to create a pasture grass with high persistence.

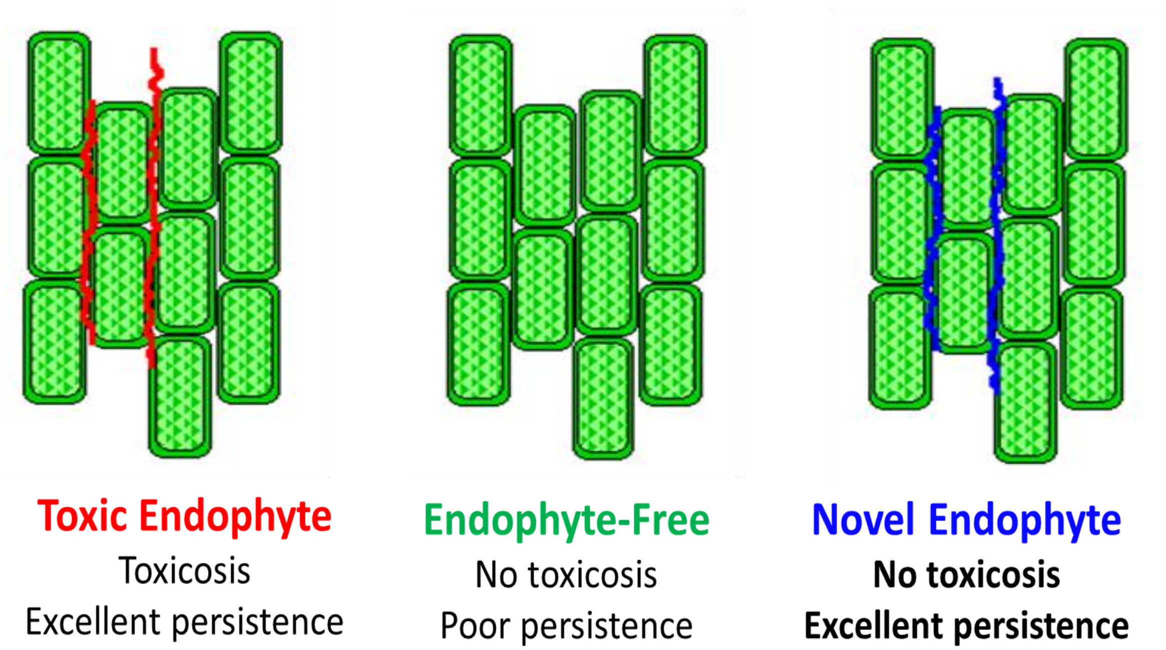

Figure 3. A common schematic of tall fescue plant cells with different endophyte status.

Deciding whether to renovate

Most producers recognize the signs of fescue toxicosis (e.g., rough hair coats, missing tail switches, poor weight gain and low reproduction). Pasture testing can aid decisions about pasture renovation and management. Pastures with low endophyte infection levels (low alkaloid pastures) could be maintained and managed for persistence. Pastures with high endophyte infection levels (high alkaloid pastures) should be renovated or managed through strategies such as increasing pasture species diversity and selecting cows with improved tolerance to alkaloids.

How much renovation is enough?

It may be challenging financially to renovate the whole farm. However, research from Arkansas (Caldwell et al., 2013) indicates that planting 25% of a farm with novel fescue for use during breeding and weaning periods can improve farm profit.

Renovating toxic pastures

Keys to successful renovation include:

- Eliminating toxic fescue plants and seed
- Ensuring viable endophyte in novel fescue
- Having suitable establishment conditions

Endophytes in tall fescue are passed from mother plant to seedling through the seed - and fescue is a prolific seed producer. To avoid contaminating a new planting of novel fescue, it is critical to kill all the existing toxic fescue and to keep any toxic seed from growing. The seed can survive for some time, but the endophyte will die by or before 18 months, thus toxic seeds should be kept out fields to be renovated for similar time. This can be managed with close grazing or clipping

Time and poor storage conditions can kill the endophyte in a seed bag - just as in the field. Use novel fescue seed that has been certified by the Alliance for Grassland Renewal (Figure 4).

Figure 4. This "Alliance" insignia, found on novel fescue seed tags or bags, indicates the seed has been tested and has viable novel endophyte. The label will also have a "use-by" date.

Establishing new stands presents risks, but many factors are within a grower's control.

- Plant in appropriate season/weather windows
- Be sure fields are clean at planting
- Ensure soil pH and fertility are adequate
- Be sure fields are not affected by carryover herbicide
- Do not plant seed too deep
- Let grass establish before planting legumes

Renovation schemes

Three general schemes (Figure 5) are used for fescue renovation. The schemes use at least two herbicide applications, with the latter helping ensure escapes are killed. The spray-wait-spray approach may be the most economical, but many farmers choose spray-smother-spray to help meet forage supply needs. The smother crops used in these systems should have upright growth habits to allow better herbicide penetration to the understory when they are killed out.

Avoid low growing grasses such as annual ryegrass or crabgrass that can cover (and protect) escapes.

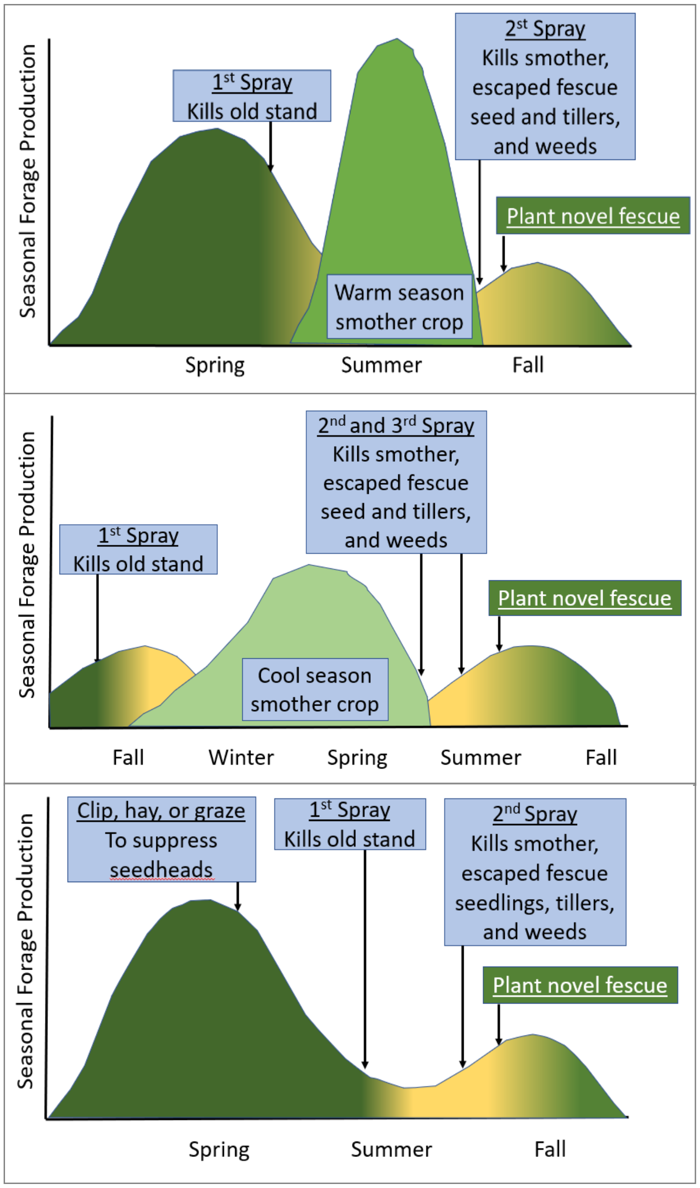

Figure 5. Spray-summer smother-spray (top), spray fall smother-spray (middle), and spray-wait-spray (bottom) schemes are used to renovate toxic fescue pastures. Note that the fall smother regime starts in fall and covers a much longer span of time.

Managing novel tall fescue for persistence

Questions about renovation

Producers' questions about converting toxic fescue pastures and hayfields to novel fescue generally center on two issues: Economics - "That seed is expensive, will renovation pay?", and Agronomics - "Will it persist like KY31?"

When determining the potential payoff from pasture renovation, factors to consider include:

- Is the land is owned or leased? If leased, for what time frame? Conversion under a short-term lease is unattractive.
- How much toxic fescue is in the forage stand - and how is that likely affecting gain and reproductive performance? Most fescue stands in Virginia are heavily (>60% and often 100%) infected and animals routinely have gains in the pound/day range.
- What is the value of cattle in the marketplace? This is the variable outside the producer's control.

Regardless, the general conclusion is that cost of fescue renovations can be recovered over two to five years, depending on the conversion method, the degree to which pastures already needed renovation from weeds/poor stand, and if financial assistance from NRCS helped offset these costs.

The question of persistence

Research studies from around the U.S. have shown that novel fescue persists as well as KY31 and other toxic fescue varieties - with one caveat: Novel fescues must be managed differently.

Endophytes, fungi living within fescue, provide the plant many survival benefits, including tolerance to drought and poor soil fertility. This is true both for wildtype (toxic) endophytes and novel (non-toxic) endophytes. However, novel endophytes do not produce toxins, and do not cause the distress and reduced intake associated with toxic fescue. That means it can be easier to overgraze novel fescue.

Managing new stands

It may be tempting to graze newly-established novel fescue stands. Resist this temptation. Converting toxic fescue to novel fescue can cause a temporary disruption to forage supply, but the effort taken to get this non-toxic fescue can be lost if the stand is grazed before the new plants are big and strong enough to withstand grazing. Generally, the stand can be grazed if it passes the "pluck test". That is, if you can pull on a plant and it is not uprooted, it can withstand grazing. A light defoliation encourages the plants to tiller, thickening the stand. Grazing or making hay on the new stand should be about encouraging the plants - not about feeding livestock or making many bales of hay.

Stand contamination and long-term persistence

Novel fescue stands only can be contaminated when toxic seeds enter the pasture and are given opportunity to grow in the pasture. The way to maintain a novel stand, free of toxic fescue, is to keep the novel fescue healthy and vigorous and to keep toxic seed out. Follow these steps:

- Maintain soil fertility. All pastures benefit from routine soil testing and appropriate fertilization. Healthy stands are better able to resist invasion by weeds - or by stray seed from toxic fescue.
- Don't overgraze or mow too close. Cutting fescue too close to the ground, too often, or both, can weaken fescue stands. This increases the opportunity for erosion and nutrient loss, which further weakens the stand. As the stand declines, spaces are created for weeds and toxic fescue seed.
- Avoid traffic damage. Grazing on wet ground (especially with new stands) can damage plants and "pug" soils. Disturbed areas around hay feeders can provide an avenue for undesirable plants, especially if the hay being fed is filled with toxic fescue seed. Use of ring feeders is not bad, per se, but the feeder should be moved regularly to avoid soil damage.
- Make hay in the boot stage. Using toxic fescue fields for haymaking is a good strategy for mitigating toxicosis, but if made too late - once seed are mature - this hay is a vector for spreading toxic seed.
- Keep "dirty", seed-laden hay equipment out of novel fields. If haymaking or clipping has to occur in stands with mature seed, avoid traveling into novel fescue fields without first cleaning the tractor and equipment.
- Do not feed toxic hay on novel pastures.
- If cattle have been on "seedy" toxic fescue stands, keep them out of novel fescue pastures for at least two days. Cattle often eat seedheads and it takes about 48 hours to pass the seed out of the digestive tract.

Acknowledgements

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ROTATIONAL BALE GRAZING: AN ALTERNATIVE WINTER HAY-FEEDING SYSTEM

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Background

Sacrifice paddocks are designated areas where cattle are confined during winter to protect other pastures from overgrazing. Bales are brought in regularly for cattle to feed on. These areas are devoid of vegetation and are strategically used to limit grazing and conserve pasture grass. The concept revolves around sacrificing a small portion of land to maintain the overall health of the larger pasture ecosystem. However, they need management and maintenance to prevent excessive buildup of animal waste and ensure cattle have adequate feed. Sacrifice paddocks require daily labor, consistent machinery usage, and cause uneven nutrient distribution and soil compaction in the paddocks (Figure 1).

Rotational bale grazing involves strategically placing large amounts of hay in a grid pattern before winter feeding. The cows are then moved onto the site, and strip grazing is used to allow cattle access to the bales at a specified rate. This is achieved by systematically giving access to new bales with a moveable cross fence. The bales remain stationary, and the livestock are progressively moved through the grid as the wire and bale ring are repositioned throughout the winter. Within these designated areas, cows can graze on the bales and any residual forage in the pasture, between the water source and the movable cross fence. The primary benefits of rotational bale grazing include reduced labor and input costs, improved soil fertility, and enhanced pasture health.

Figure 1. Sacrifice paddock at SVAREC after winter hay feeding.

This study was conducted to determine the impact of winter rotational bale grazing and sacrifice paddocks on the spatial distribution of nutrients and spring forage recovery in the Southeastern United States.

Site preparation and methods

This study was conducted at the Shenandoah Valley Agricultural Research and Extension Center (SVAREC) over three consecutive winter seasons (from 2022-2024, about 60 days each season, beginning mid-February and ending mid-April). The two treatments: rotational bale grazing and sacrifice paddocks, each had three replicates. Each replicate had eight cow/calf pairs; each pair needed one bale around every three days. The first of the three years of the trials began on February 16, 2022, and ended on April 15, 2022.

For the rotational bale grazing treatment, a total of 15 tall fescue paddocks were designated, approximately two acres each. Each of the three replicates had five paddocks subdivided into four equal strips (0.5 acres each), and 20 bales were evenly distributed across the paddocks before the start of winter hay feeding. This setup allowed for controlled grazing by providing cattle access to a new strip with a new bale as needed.

Three pre-existing sacrifice paddocks, also approximately two acres each, were used as the comparative treatment. A bale was brought to each sacrifice paddock and placed in designated feeding areas approximately every three days for the eight cow/calf pairs in each replicate.

Soil grid sampling has previously been conducted three times throughout this study. Once before the first round of bale grazing began (October 2021), once between the first and second year (October 2022), and once after the second year (October 2023). To collect these samples, each 0.5-acre strip was divided into three grids in both the sacrifice paddocks (Figure 2), and the rotational bale grazing paddocks. Each paddock had four strips, so each paddock had 12 grids. In each grid, 10, 0–4-inch soil cores were collected and combined, giving us 12 soil samples per paddock.

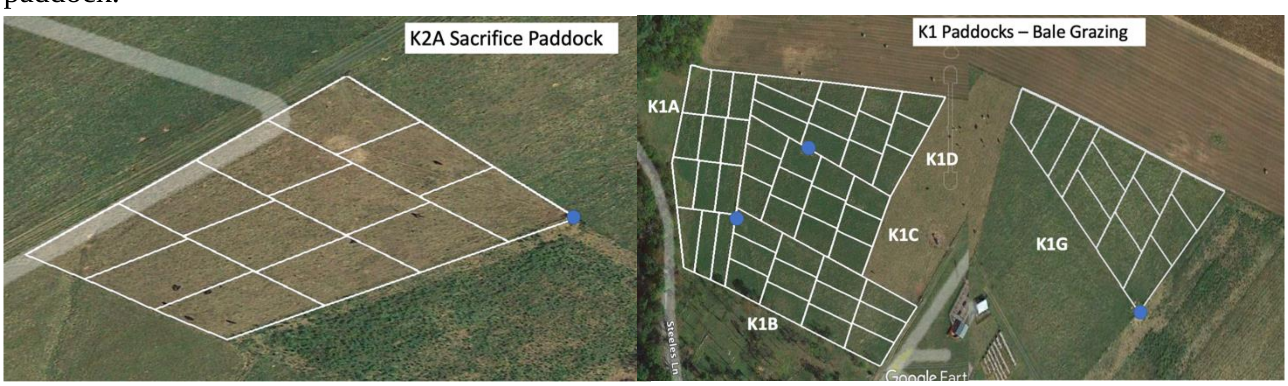

Figure 2. Soil grid sampling layout of sacrifice (left) and rotational bale grazing paddocks (right).

Results and discussion

This study began by examining the effectiveness of strategically placing hay bales in rotational bale grazing pastures, especially in nutrient-deficient areas, to improve nutrient concentrations over a two-year period in specific pasture regions. In the sacrifice paddock treatment, significantly higher Mehlich 1-phosphorus concentrations were found in soils near the permanent hay ring site, exceeding 80 mg/kg. This was due to over two decades of winter hay feeding in sacrifice paddocks, which resulted in phosphorus enrichment throughout the paddock (Figure 3A). Mehlich 1-phosphorus levels were consistently lower in soils farther from locations frequently visited by animals, such as water sources and shaded regions (Figure 3B). This method could provide a practical solution for farmers to decide where to place bales without the need for extensive grid soil sampling.

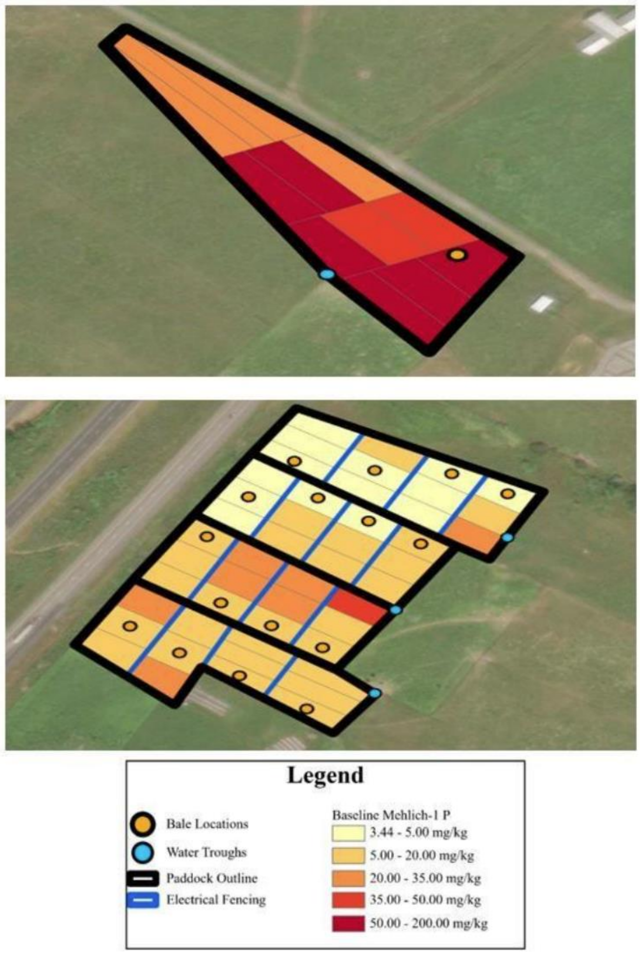

Figure 3. Baseline Mehlich 1-phosphrous in soil sampling grids. A) Pre-established sacrifice paddock B) Paddocks to be used for rotational bale grazing.

As shown by the Bale line being above the No Bale line in Figure 4, Mehlich 1-potassium increased in soil sampling grids where the bales were placed. This indicates that residual hay and waste deposition from cattle from bale placement successfully increased nutrient inputs from manure and residual hay in these areas that were initially lowest in nutrient status. However, similar increases in Mehlich 1-phosphorus were not observed, likely due to lower phosphorus content in hay compared to potassium and insufficient phosphorus inputs to show changes over two years (Figure 5).

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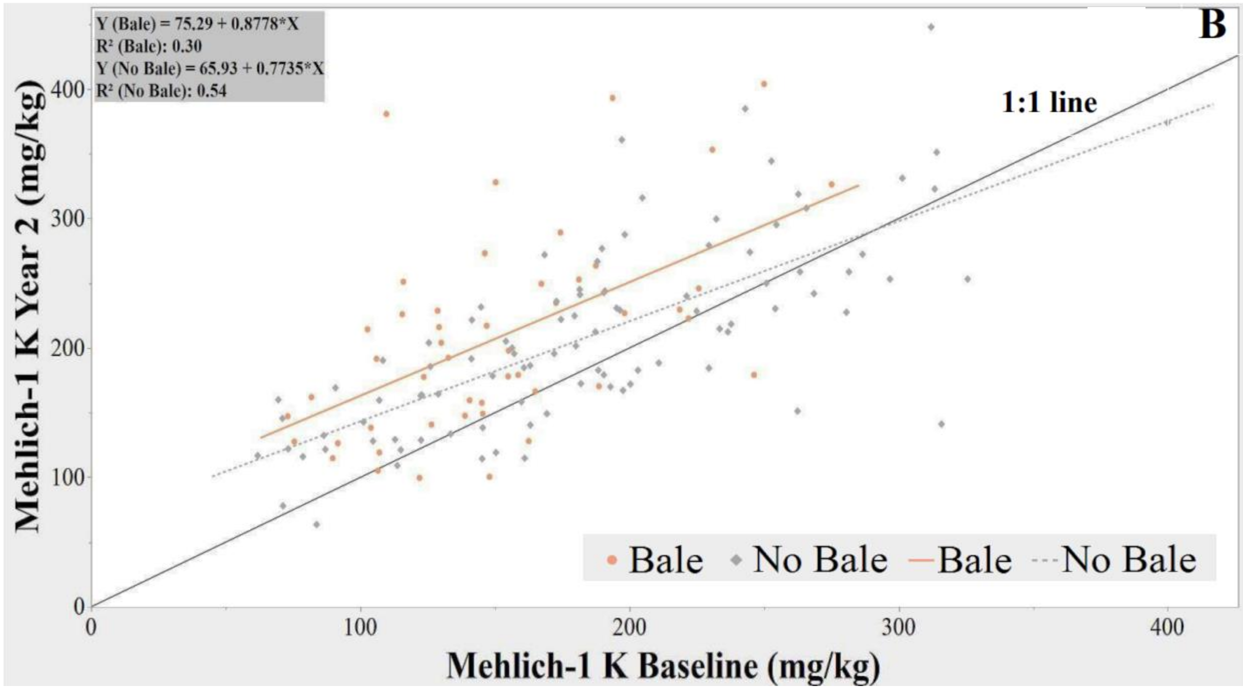

Figure 4. Change in Mehlich 1-potassium in the rotational bale grazing treatments from baseline to the second year of treatment.

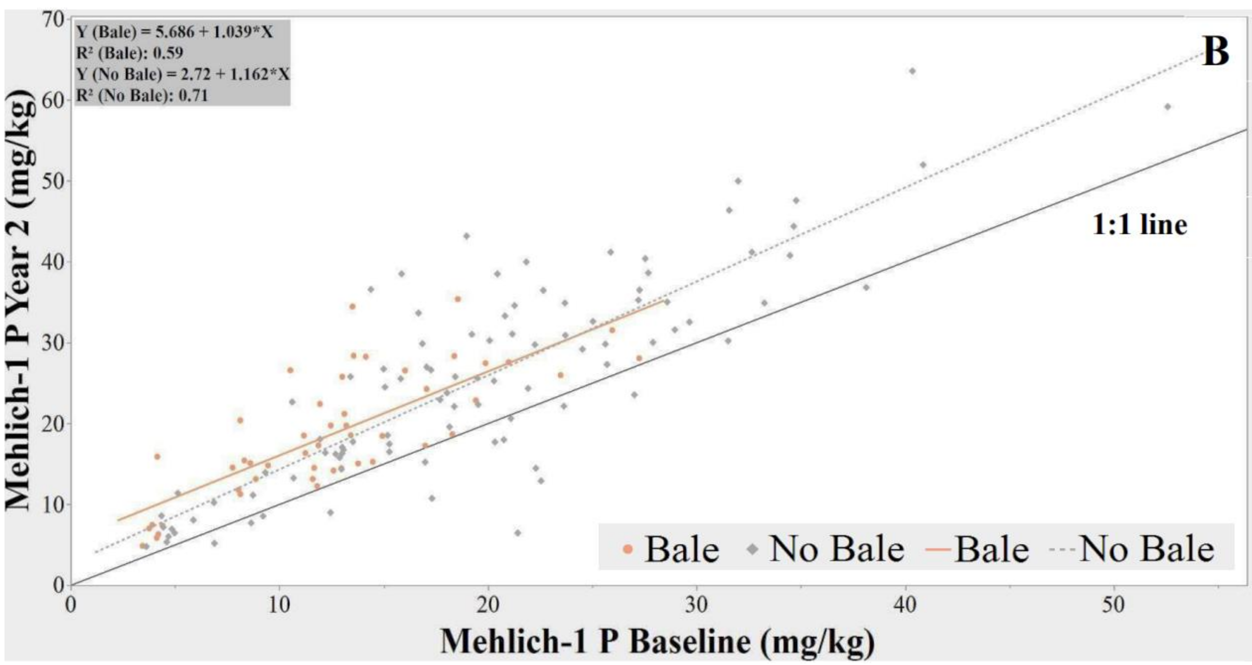

Figure 5. Change in Mehlich 1-phosphrous in the rotational bale grazing treatments from baseline to the second year of treatment.

This study also evaluated the impact of rotational bale grazing on spring forage recovery compared to a conventional sacrifice paddock system, as well as the feasibility of using remote sensing to estimate forage biomass. Manual biomass sampling and drone flights were conducted in the springs of 2022 and 2023 across both rotational bale grazing and sacrifice paddock systems. The results suggest that over time, as manure nutrients break down, the areas where bales were placed in the rotational bale grazing system will recover (Figure 6). The rest of the rotational bale grazing pasture, where no bales were placed, will achieve the same recovery and biomass as a rest paddock in the sacrifice paddock system. Drone images were successfully used to estimate whole paddock biomass (Figure 7). Despite the effectiveness of drone imagery in creating a biomass estimation model, the process took significantly longer than manual biomass sampling.

Figure 6. Recovery of biomass in area where bales were placed in rotational bale grazing paddocks from April 21, 2023, right after winter hay feeding concluded (left), and again on June 6, 2023 (right).

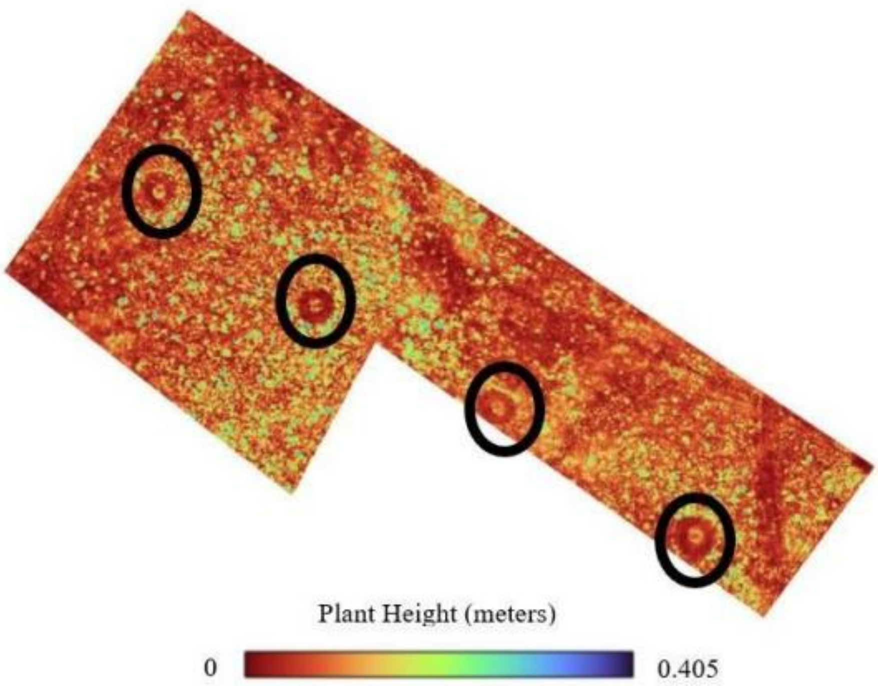

Figure 7. Visual map displaying plant height for a rotational bale grazing paddock made with drone images. Circles indicate areas where bales were placed in the paddock.

Future studies

This study will continue to compare the effects of rotational bale grazing versus using a sacrifice paddock on soil health. The analyses for soil health indicators will include soil texture, organic matter, pH, CO_2 burst tests, aggregate size fractionation, particulate organic matter (POM), mineral-associated organic matter (MAOM), and permanganate oxidizable carbon (POXC).

Additionally, economic data has been collected to compare the costs associated with each feeding system. This includes variable and fixed costs, as well as revenue. Variable costs encompass the cost of hay, mineral supplements, veterinary and medicine costs per cow, value of stockpiled pasture, amount of pasture used per cow (including the cost of land usage), fence repairs, moving electrical fencing, different amounts of electricity used in each system, machinery usage, and labor. Fixed costs include shelter/wrapping costs for hay, breeding, machinery prices and associated interest and depreciation, storage costs for equipment, insurance premiums, and property taxes. Revenue will be assessed by the quality of calves (via body condition scores) and the market price of calves (by weight).

Acknowledgments

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IMPACT OF IMPLANTING NURSING CALVES ON COW AND CALF PERFORMANCE

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Introduction

Implanting beef cattle is a prudent practice that can improve calf growth and performance as well as producer return on investment. Growth promoting implants are approved for all phases of beef cattle production (cow-calf, stocker, feedlot). Reviews of published literature find that the impact of implanting nursing calves improves calf average daily gain by +0.10 to +0.12 lb a day over control calves with commercially available implants (Selk, G., 1997). However, surveys of cow-calf producers indicate only 37% of farms with 100+ cows implant their steer calves, while only 9% of producers with less than 100 cows implant their steer calves, (Vestal, et al., 2007). Another study found only 33% of cow-calf producers use growth promoting implants nationwide (Stewart, 2013). Though an expansive library of literature documents the benefit of implanting nursing calves on the average daily gain of the calf, there is limited data on the potential impacts on the dam of the implanted calf. The purpose of this study is to demonstrate the benefit of implanting nursing calves on average daily gain and weaning weight; and explore any impacts of implanting the calf on the calf's dam including body condition score, body weight and pregnancy status. Recently, the Food and Drug Administration (FDA) issued a ruling stating that growth promoting implants may only be used once in a production phase, unless otherwise stated on the product label, effective July 1, 2023. Due to this ruling, as no implant products are approved for reimplantation in the preweaning phase cow-calf producers may only implant nursing calves once. Producers should develop effective implant strategies to maximize calf crop weight gains and net revenue.

Methods

There are several brands of FDA approved implants for nursing calves. For this study, Synovex C® (100 mg progesterone/10 mg estradiol benzoate) was used (Zoetis, Kalamazoo, MI). Synovex C® is approved for nursing calves 45 days and older up to 400 lbs. Cattle used for the study included the 1st calf heifer and spare cow herd and their calves at Virginia Tech's Shenandoah Valley Agricultural Research and Extension Center (SVAREC) from 2021 through 2024. All implanting procedures were approved by the Virginia Tech Institutional Animal Care and Use Committee. All calves in the project were born between September 2 and November 29 in 2021, 2022 and 2023.

A total of 32 cow-calf pairs were included in the study in both year one (2021-2022) and year three (2023-2024) and 34 pairs were included in year two (2022-2023). Cow weights were recorded prior to the beginning of the trial during pre-breeding vaccines prior to estrus synchronization work, approximately 25 days prior to CIDR insert and implantation (Table 1). These numbers represent under half of the total 1st calf heifer and spare cow herd which was 65 total females in year one, 67 in year two, and 85 in year three.

Table 1. Pre-trial November (Day -25) cow weight (WT) and body condition score (BCS) for all years.

Categories	Number of females in category		November WT			November BCS		
	Control	Synovex C	Control	Synovex C	P Value	Control	Synovex C	P Value
1st calf heifers	21	20	987	961	0.280	3.95	3.70	0.360
Spare cows	29	28	1254	1265	0.760	4.34	4.21	0.640
All females	50	48	1142	1138	0.920	4.18	4.00	0.920

All cows were exposed to one service of artificial insemination after a 7-day CO-Synch + CIDR® estrus synch protocol and five days later were exposed to natural service by a bull for 61 days for a 66-day breeding season. In year one (2021-2022), it was determined that later born heifers should be included in the study due to the greater number of heifers born in the calving season. In year two (2022-2023) and year three (2023-2024) only steer calves and their dams were included in the study. Mature cows and 1st calf heifers were stratified by age and assigned randomly with their calves to either the control (n=50, average of 17 per year) or implant treatment (n=48, average of 16 per year). Calves were implanted at pre-breeding CIDR insert for the cow herd (day 0). Calf weights were recorded at implantation (day 0), pregnancy check (day 104), and weaning (day 129). Average calf age at implantation was 64 days and average age at weaning was 178 days. Calf ears were palpated at pregnancy check (years one and two) or weaning (year three) to insure proper implant placement. Beginning trial calf weights averaged over all three years are included in Table 2.

Table 2. Average December calf weight (WT) for all years.

	Control	Synovex C	P Value
Calf starting weight, lb	183	189	0.541
Number of calves in treatment	50	48	

First calf heifers and the mature spare cow herd were managed on different pasture allotments in the beginning of the trial period in all three years from December to February/March before being combined as one herd until weaning. Pasture forage samples to determine yield and quality of stockpiled grass were periodically collected through the trial period. Forage quality samples were shipped to Cumberland Valley Analytical Services (Waynesboro, PA) for analysis. Hay/baleage feeding was begun during periods of snowy weather and after stockpiled grass was exhausted. Year by year forage data is available in Table 4. Daily farm hay feeding records for total as fed hay and baleage were available for years two and three. Total hay and baleage dry matter fed daily was estimated using these feeding records and dry matter and moisture percentage from the forage analysis. Body weight of the entire herd was estimated for years two and three using March pregnancy check weights. In year two, estimated daily dry matter fed to the herd was 2.94% of total herd body weight. In Year three, estimated daily dry matter fed of hay and baleage was 2.22% of body weight.

Table 3. Forage characteristics for spares and 1st calf heifers stockpiled forage and hay samples, including total digestible nutrients (TDN), crude protein (%), and dry matter (DM) yield

Year	Herd	Forage description	TDN (%)	CP (%)	DM yield (lb/ac)
2021-2022[1]	1st calf heifers	Hay	59.2	11.2	N/A
		Stockpile	60.3	10.9	2,381
	Spares	Hay	54.4	10.0	N/A
		Stockpile	56.5	10.7	1,956
2022-2023[2]	1st calf heifers	Hay	53.7	15.4	N/A
		Stockpile	53.7	10.3	2,387
	Spares	Hay	53.8	15.2	N/A
		Stockpile	53.6	9.4	2,781
2023-2024	1st calf heifers	Hay	57.5	13.0	N/A
		Stockpile	54.9	7.3	2,487
	Spares	Hay	57.0	12.4	N/A
		Stockpile	53.5	8.2	3,337

[1] 1st calf heifers and Spares were combined on 3/22/2022 and fed baleage from 3/22/2022 to weaning 4/19/2022.
[2] 1st calf heifers were combined on 2/3/2023 and fed hay and baleage from 2/13/2024 through weaning on 4/18/2023. Hay and baleage availability averaged through 3/31/2023. Estimated hay and baleage made available to herd were 2.94% of body weight in dry matter (DM) using the weight of all cows and calves at March preg check.
[3] 1st calf heifers and spares were combined on 2/29/2024. Hay and baleage availability averaged through 3/31/2024. Estimated hay and baleage made available to herd were 2.22% of body weight in dry matter (DM) using the weight of all cows and calves at March preg check.

Data was analyzed using Microsoft Excel® single factor Analysis of Variance (ANOVA). Differences were determined significant if $p<0.05$.

Results and discussion

Implanted calf weaning weights were 31 lb greater than non-implanted control calf weaning weights (Table 4; P=0.020). Additionally, implanted calf WDA tended to be 0.14 lb/day greater (P=0.034) than that of control calves, while average daily gain for implanted calves exceeded the average daily gains of control calves by 0.19 lb/day (P=0.002). No significant differences were seen in cow weights, body condition score, or days pregnant at pregnancy check (Table 5).

Table 4. Calf weaning weight (WT), weight per day of age (WDA) and average daily gain (ADG).

Variable	Control	Synovex C	P Value
Calf weaning WT, lb	356	387	0.020
WDA, lb	1.89	2.03	0.034
ADG, lb	1.40	1.59	0.002

Table 5. Cow body weight (BW), body condition score (BCS), days pregnant, average daily gain (ADG) at March pregnancy check.

Variable	Control	Synovex C	P Value
1st calf heifer BW, lb	987	961	0.284
Spare cow BW, lb	1254	1265	0.765
All females BW, lb	1142	1138	0.924
1st calf heifers BCS	3.95	3.70	0.356
Spare cow BCS	4.34	4.21	0.637
All females BCS	4.18	4.00	0.369
1st calf heifers ADG, lb	-0.73	-0.87	0.326
Spare cow ADG, lb	-1.19	-1.07	0.499
All females ADG, lb	-0.99	-0.98	0.929
1st calf heifer days bred at preg check	80.2	89.5	0.378
Spare cow days bred at preg check	82.6	88.0	0.343
All females days bred at preg check	81.6	88.6	0.195

Calf response to implants was stronger in year one and year two, with implanted calves (n=32) weighing 45 lb ($p<0.05$) more than control calves (n=34) at weaning, with an implanted calf weight per day of age 0.20 lb/day greater than control calf and average daily gain being 0.25 lb/day greater for implanted calves over control calves., In year three, calf response to implants was virtually negligible, with no significant difference between implanted calves and non-implanted calves. This non-response to implants is theorized to be due to two factors. First, implants used in year three were set to expire in February 2024. Thus, with the implants expiring in February, they would not have resulted in added growth during the critical March and April time periods. Secondly, the Shenandoah Valley experienced a severe drought in 2023, with below average rainfall in the spring and drought conditions persisting into the summer and late fall. These conditions reduced pasture forage availability in the early winter. The 1st calf heifers and spare herd were fed hay during the early fall to allow fall grass a chance to stockpile. However, stockpiled grass production during the drought was very limited. Furthermore, stockpiled grass growth tested numerically lower for crude protein. This is likely due to cool season grasses undergoing drought stress. Additionally, hay supplementation was slightly lower at 2.22% body weight in dry matter in year three compared to in year two, during which hay was fed at 2.94% body weight. Based on these findings it is recommended that producers provide fall calving cow calf pairs with adequate quality and quantity of forage, and if implanting, use implants that will be active for the full payout period prior to weaning.

Economics

To evaluate cost and return for implanting nursing calves prior to weaning, implant costs were assumed to be $1.50/head, with labor assumed to be $0.88 head ($16/hr working 18 calves in an hour), and disinfectant and supplies to be $0.10/head. Total cost to implant a calf was calculated to be $2.48/head. Calf prices were sourced from the Virginia Weekly Cattle Auction Summary (USDA-AMS/VDACS Market News Service 2187) for the third week of April for all three years. Data from these estimates are reported in Table 6.

Table 6. Predicted economic return for implanting calves prior to weaning.

Weaning weight, lb	Treatment	Sex	Price/lb	Gross Return	Net Return
387	Synovex C	Steer	$2.53	$980.35	$84.61
356	Control	Steer	$2.51	$893.26	
Weaning weight, lb	Treatment	Sex	Price/lb	Gross Return	Net Return
387	Synovex C	Heifer	$2.06	$795.49	$66.19
356	Control	Heifer	$2.04	$726.82	

Naturally, these assumptions change with prices and weights. However, for calves designated to be sold at weaning in a non-natural market, implanting provides producers an increase in net return on investment. The years used in this study reflect a high point in the cattle cycle, with year three perhaps being the highest market in history. Additionally, cattle in this study were weaned at an average under 400 lb. This weight average received a minimal price slide for the heavier implanted calves. Producers should expect the price slide for heavier calves to reduce the gain in net return for an implant program. Using 10-year average prices from VDACS Market News of $1.81 for 4-weight steers and $1.73 for 5-weight steers puts the tentative return per head at $13.17/head. Conservative estimates for return to a nursing calf implant program could be expected to be $20/head to $50/head. The cattle cycle may impact this return to a large degree. In the years of this study, cattle prices continued to go up, increasing the value of implanting. It is reasonable to state that in times of high cattle prices, implanting cattle will likely produce a greater return than in times of low cattle prices.

Non-hormone treated cattle (NHTC) or natural cattle often command a premium in the market place. Producers who are not implanting cattle should calculate a breakeven premium (BE) needed for not implanting calves. A suggested formula for this breakeven is below:

$$Breakeven = \frac{(\text{price } \times \text{additional lb gained from implanting}) - \text{cost of implanting}}{\text{weaning weight without implants}}$$

If implanting calves adds 30 lb to the calf weaning weight and 5-weight calves are valued at $250/cwt, the breakeven premium for calves sold as NHTC would be an additional $0.15/lb to equal the value of implanted calves. Data from VDACS Market News shows that the required breakeven premium ranges from $0.12/head to $0.20/head.

Conclusions and continuing work

The benefits of implanting nursing calves to calf productivity have been well established, and our results from a fall-calving herd in Virginia corroborate this body of work. With adequate nutrition supplied by medium-quality stockpiled forage, hay, and baleage, improvement to calf gains when implanted can be realized over non-implanted calves. A production system where cows are gathered for estrus synchronization and AI protocols offers an opportunity to implant calves at an average age of 65-45 days.

References

Vestal, M.C. Ward, D. Doye, and D. Lalman. 2007. Cow-calf Production Practices in Oklahoma – Part I. OSU Extension Fact Sheet AGEC-245, Oklahoma Cooperative Extension Service, Oklahoma State University.

Selk, G. 1997. Implants for Suckling Steer and Heifer Calves and Potential Replacement Heifers. Oklahoma State University Implant Symposium.

Stewart, L. 2013. Implanting Beef Cattle. University of Georgia Extension Bulletin 1302.

USDA- Agricultural Marketing Service. Virginia Dept. of Ag. And Consumer Services. 2022-2024 Virginia Weekly Cattle Auction Summary, week of 4/17-4/23. AMS_2187.

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SILVOPASTURE: TREE AND FORAGE ESTABLISHMENT

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Using trees to mitigate heat stress for livestock is not a new practice – but it can be done poorly. Turning livestock loose in the woods generally results in timber degradation while offering little forage value. Planting a tree or two in a pasture often leads to overcrowded mud pits. These conditions create vectors for both livestock and plant diseases and often lead to dead trees.

Silvopasture, on the other hand, is the more intentional integration of trees, livestock, and forages for various benefits, including, but not limited to reduced livestock stress, improved forage quality, and timber stand improvement (Fike et.al, 2016). Creating and maintaining these benefits through silvopasture requires effort due to the complex interactions among plants and animals. In this paper, we present our thoughts on how these objectives might be achieved while documenting several silvopasture demonstration projects currently underway at the Shenandoah Valley AREC.

Creating new silvopastures

There are two basic options for creating new silvopastures on a farm.

Option A:

Pros
- Trees are already established and immediately provide value from shade

Cons
- Tree species is a "work with what you have" proposition
- Sites can require significant clearing and cleaning to establish forage
- Danger of excessive thinning which may shock the remaining trees, resulting in degraded timber and even tree death

Option B:

Pros
- Tree species and spacing can be controlled

Cons
- Takes some years to get shad
- The site requires management (tree protection, weed control) during the establishment phase

A hybrid option with components of both "A" and "B" above is to clear an existing forest and then create a new silvopasture by planting both trees and forages simultaneously. This differs from Option B with additional complexities due to site-cleanup and preparation.

Creating silvopasture by land-clearing (or clear-cutting?)

The difference between land-clearing and clear-cutting is that one (land-clearing) changes the land-use from forest to something else, such as a field, parking lot, or house. Clear-cutting, on the other hand, is a silvicultural practice used to regenerate a forest stand with shade intolerant species (e.g. poplar trees). In the case of a recent project at the Shenandoah Valley AREC, we are doing both (Table 1). The land-use will change to include agriculture, and we are planting trees for the next forest stand. Stand D6 (Figure 1) was a nearly 11-acre mixed hardwood forest mostly comprised of oak (much of it over-mature), cherry, and white pine. It contained an estimated 140 tons of pulpwood and 83,000 board feet of sawtimber. The timber was sold in 2021, harvested in 2022, and the site was re-planted with trees in 2023. We hired a contractor to pile some of the leftover slash in 2022, and we spent some of the winter months burning the piles. We also hired a pilot to aerially apply burndown herbicide (which included imazapyr, metsulfuron, glyphosate, and a nonionic surfactant in the mixture) in late summer 2022.

Figure 1. Map of clearcut timber stand in conversion to silvopasture.

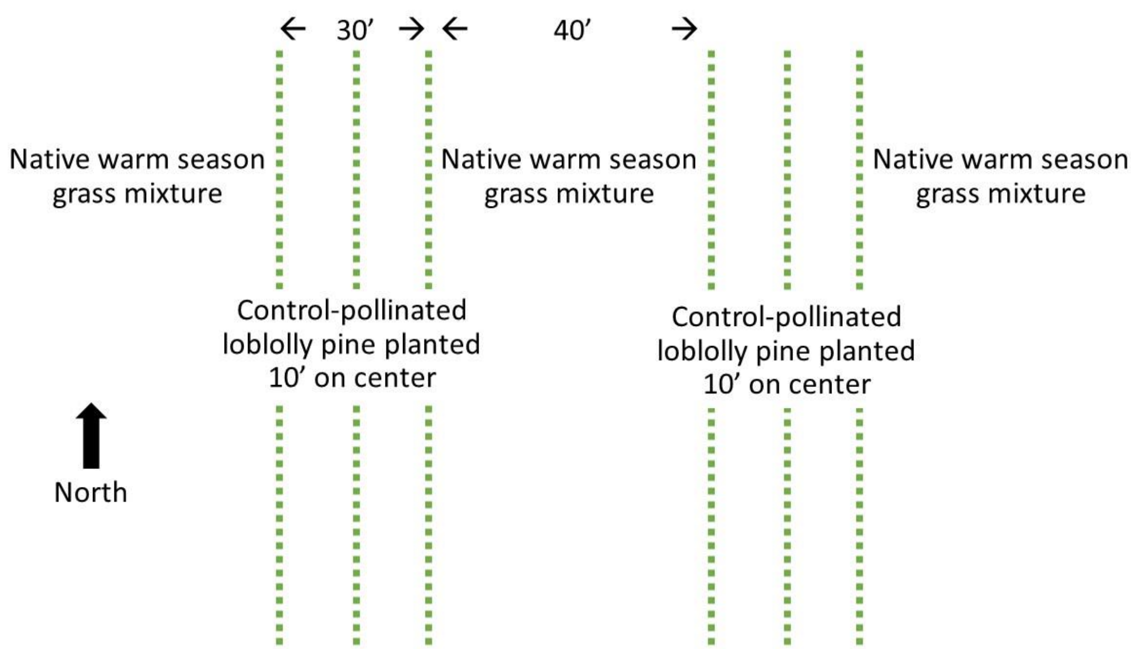

Figure 2. Spatial arrangement of tree and forage establishment in D6 stand.

While many tree species may be utilized in a silvopasture (Fike et.al, 2024), we planted control-pollinated loblolly pines from the Virginia Department of Forestry State Nursery. We chose these improved trees for their greater uniformity and rapid establishment and growth. The trees were hand-planted in triple row sets with 10x10' spacing in March 2023. The triple row sets (14 sets) average about 450’ in length with cleared alleys measuring 40’ in width between the sets of trees (Figure 2). The placement of each tree was laid out and marked prior to tree planting to ensure straight rows and equidistant spacing of trees.

While some studies have indicated that pine growth is maximized in double row sets, we selected the triple row set arrangement with the hope that the outer rows will “prune” the interior row for an improved sawtimber harvest at some point in the future. The two outer rows will likely be harvested as pulpwood in a couple of decades once their role is complete.

We chose native warm-season grasses for the forage understory based on site features. Although cool-season grasses have minimal forage production loss under the light shade of some silvopastures and warm-season grass productivity can decline more significantly in shaded sites, soil conditions drove this decision. After harvest, we realized the topsoil is quite thin, with very poor nutrient status (pH: 4.8; Mehlich 1 phosphorus: 12 ppm; Mehlich 1 potassium: 48 ppm). Thus, we decided to establish native warm season grasses because they are better adapted to acidic soils and low phosphorus and potassium levels, and they will establish better than typical pasture grasses on thin, shaley soils. These grasses are also more water use efficient, and their summer growth will fit our plan to utilize this pasture more heavily during the hot months of the year.

Prior to planting these grasses, we hired a contractor to mulch where we were planning to seed the native grasses in the alleys. The contractor used a 500 HP Tigercat forestry mulcher to shred the remaining branches and any stumps in the alleys between the tree sets. Along with the piling and clearing of the slash piles, this was the most expensive site preparation practice for the entire project, but we were trying to create a clean seedbed with minimal log and stump residue in a short period of time. This would help with our ability to seed the grasses successfully as well as to maintain the site in the future. We also believed that by pulverizing most of the slash, we could minimize the risk of livestock injury.

After the alleys were mulched and some broadleaf weeds had begun to regrow, we sprayed Plateau herbicide (a.i. imazapic) at 6 oz/ac on May 3, 2024. Following spraying, we harrowed the alleys twice with a chain harrow.

The native grass seeds were broadcast along with 200 lb/ac of pelletized lime as a carrier using a Herd Model 750 3-point hitch broadcast seeder on May 8, 2024 (Figure 3). Our target seeding rate was 8 lb/ac big bluestem (*Andropogon gerardii* cv. Pawnee), 4 lb/ac indiangrass (*Sorghastrum nutans* cv. Rumsey), and 2 lb/ac little blustem (*Schizachyrium scoparium* cv. Aldous). For those who know the challenge of calibrating a broadcast seeder, you’ll be pleased to hear that we ended up very close to our target seeding rate… after going over the entire site twice. A similar mixture was hand-seeded in between the rows of planted trees.

No soil amendments (besides the small amount of lime used at seeding) were applied to either the trees or the alleys planted to grass. As of early summer, the grasses have begun to germinate and grow despite some dry weather in late May and most of June. While most of our warm season annual grass weeds (e.g. foxtail and crabgrass species) have been well-suppressed by the Plateau herbicide, the broadleaf weeds have continued to grow and will likely need to be controlled with an additional herbicide application in the middle of the summer once the native grasses have begun to tiller.

Figure 3. Broadcast seeding native grasses following mulching, harrowing, and spraying a pre-emergent herbicide.

Table 1. Project activities and income or costs; costs do not include time spent by farm crew on cleaning or planting activities.

Time	Activity	Income/Cost
Dec. 2021	Timber harvesting stated	Cost deducted out of final sale
Mar. 2022	Timber harvest complete	+$13,877.42
Aug. 24, 2022	Site preparation burndown application	-$2,578.99
Jan. 2023	Piling slash and clearing residue	-$11,850
Feb.-Mar. 2023	Burning slash piles	--
Mar. 27, 2023	Loblolly pine seedlings	-$368.00
Mar. 27, 2023	Tree planting	-$817.50
2023-2024	Picking up trash	--
Apr. 16-18, 2024	Forest mulching between sets of trees	-$9,600
May 3, 2024	Broadleaf and pre-emergent grass weed herbicide and surfactant	-$100.50
May 8-9, 2024	Native warm season grass seed	-$2,266.28
Project balance		**-$13,703.85**
Cost per acre		**$1,257.23**

Our primary concern is the eventual productivity of the forage. Despite soil descriptions indicating pasture as a potential land use (Figure 4), the soils on this site are extremely thin and this became obvious following timber removal. Narrow alleys also may limit productive forage growth, but these will widen as we take the outer rows for pulp.

The original 11-acre woodlot had been used as a livestock loafing lot and trash dumping site since the mid-1900s. It was also not contiguous with other wooded tracts, making it difficult to manage for forestry due to its small size. Thus, this change in land-use has cleaned up the site, better incorporated it into the overall farm operations, and added more diversity for grazing needs.

Symbol	Soil type	Acres
22B	Fredrick silt loam, 3-8% slope	1.1
22C	Fredrick silt loam, 8-15% slope	0
33C	Litz-Chiswell-Groseclose complex, 8-15% slope	4.8
33E	Litz-Chiswell-Groseclose complex, 15-35% slope	4.0

Texture: Loamy-skeletal

Soil Series Use & Vegetation

Litz: A large portion is cleared and used for permanent pasture. A small part is used for row crops consisting mainly of corn, small grain, and mixed hay. Native vegetation includes oaks, hickory, yellow poplar and locust.

Figure 4. USDA-NRCS Web Soil Survey of D6 site.

However, while we were aware of the presence of old junk on the site, it has proven more difficult to clean up than anticipated. Each time we pick up a piece of trash, we uncover another dozen pieces of broken glass and wire fence fragments. The effort required to clean the site following the timber harvest has been substantial, and we have spent a lot of time and money trying to clean up the slash and trash.

Finally, we’ve experienced some anxiety about successful pine establishment given the extremely dry spring and summer of 2023 and some predation by deer. Anecdotally, the pines are looking good despite these stresses.

While we don't anticipate the need to release the pine from competing vegetation, this will be monitored, and we will likely need to apply a selective broadleaf herbicide in 2024 to manage the weed pressure for the grasses. We anticipate waiting another few years before introducing livestock to ensure that our forages are well established and that the growing points of the pine trees are beyond the reach of browsing livestock.

Renewing silvopasture

There may be some situations when a farmer will want to establish new trees within an existing pasture or even a heavily thinned silvopasture to fill gaps or add diversity. In the case of silvopasture stand J (Figure 5), we replanted some trees following the loss of approximately half of the the silvopasture tree stand due to the Emerald Ash Borer.

Figure 5. Aerial view of thinned silvopasture site (Google Maps).

In 2018, we planted 1-year-old bareroot tree seedlings using various protection methods in a silvopasture that we manage with stocker calves each summer (Pent et.al, 2020). Protection approaches included: commercial tree guards (Arbor Shield™, no longer available on the market to our knowledge), homemade tree cages (like a tomato cage) made from fixed-knot fence, conventional tree tubes, and no protection. Homemade cages were constructed from 42" lengths of fixed-knot fencing and slightly larger than 12" in diameter. These and the Arbor Shield cages were secured with zip ties to three 5' rebar (1/2") stakes driven 1' into the ground. The tree tube was secured with a PVC tube (gray, outdoor conduit) rather than a rigid wooden stake with the thought that the tube and tree might better survive if secured with a "bend, don't break" approach.

Initial data reported in 2020 showed trees with no protection or with a conventional tree tube were extremely vulnerable to damage and destruction. Conversely, the Arbor Shield guards and the homemade cages offered excellent and equivalent protection. At that point in time, most trees had not grown out (above the top) of their protection method.

Figure 6. Arbor Shield tree guard (left) compared to a homemade tree cage (right).

Trees were evaluated again in August 2023. All of the Arbor Shield guards and homemade cages were still in place, but many of the trees had died due to herbicide damage, competition with grass and weeds, and potentially from other challenges. Of the 12 black locust trees protected by the Arbor Shield cages, nine were still alive, while of the 12 black locust trees planted in the homemade cages, seven were still alive. Only one of the 12 black locust trees planted in a tree tube survived, and none of the trees without protection survived.

Interestingly, eight of the 12 red oaks in the Arbor Shields survived while only three of the 12 red oaks in the homemade cages survived. It is not clear why there was such a difference between the two treatments as both cages appeared to still be functional and capable of protecting the trees. Vegetation competition seemed to be the primary reason for the red oak mortality.

Most of the cages around the black locusts were removed in August 2023 as the trees had grown sufficiently to survive any pressure from the livestock. While the Arbor Shield guards showed evidence of improved red oak viability five years after establishment, the materials for this level of protection cost $24.68 compared to $8.30 for a homemade cage.

Historically, tree tubes have been secured with rigid wooden stakes. This may not be desirable for tree development because the rigid system prevents the formation of brace wood in the tree stem. Some modern tube systems use a flexible fiberglass stake on the inside of the tree tube to good effect, but livestock still need to be kept off of the tubes. We can't be certain, but the PVC pipe concept may have failed because the pipe was too short – when the tube and pipe were pushed, the upper zip tie may have slid off of the pipe, allowing the tube to flop over.

New trees in an old pasture

Another project was initiated in 2023 with control-pollinated loblolly pines planted into a tall fescue-based pasture. This 17-acre pasture (Carr 2) has some shade available from sparse trees, but there is a large open area within the pasture where we wanted to evaluate establishing fast-growing pine trees with various protection methods from cattle.

The trees were planted in March 2023 in four parallel rows with 60' between rows and 10' between trees within rows. Each row is around 500' in length. The orientation of the rows is roughly southwest to northeast. Glyphosate (2% solution with 0.5% nonionic surfactant) was sprayed to kill the sod around each tree prior to planting.

Following establishment, we installed three electric fences designed to keep the cows away from the trees; the fourth row was left exposed to the cattle with no fencing or protection. Single wood, non-braced posts were used at the end of each row, and 0.17 Joule solar fence chargers electrify the wires. The first fence and row included a single strand of polywire directly over the row of trees and held off the ground by tread-in UV-stabilized plastic posts at a height of 36". The second fence and row included two strands of polywire offset from the trees by about 12" on each side and held off the ground by tread-in UV-stabilized plastic posts at a height of 36". The third fence and row included two strands of smooth high-tensile 215 kPSA wire held off the ground by a 16" double pigtail offset insulator secured to wood posts at 36" off the ground. The cost per linear foot of these three fence designs (not including the price of a solar charger and installation labor) was $0.19, $0.37, and $0.60, respectively.

Figure 7. Fences installed over planted pine seedlings included electrified single polywire left) electrified double polywire (center), and electrified double smooth high tensile wire (right).

Herbicide (2% Arsenal with 0.25% nonionic surfactant) was spot-sprayed over the pines in May 2024 for vegetation control. We stocked this pasture with a herd of 59 cows over three different grazing periods for seven days each in 2023.

As of July 2024, out of around 50 trees planted per row, 20 live trees were found in the single polywire row, 29 live trees were found in the double polywire row, 30 live trees were found in the double high-tensile wire row, and 9 trees were found in the control row with no protection. We will continue to evaluate tree viability and growth in the coming years, but these preliminary results again indicate that some protection is critical to ensure tree seedling survival in pastures stocked with livestock.

Funding for silvopasture in Virginia

There are currently several sources of funding that farmers and landowners can explore for potential financial and technical assistance for silvopasture and other agroforestry establishment projects.

- **Catalyzing Agroforestry** https://www.appalachianforestfarmers.org/emef
  - Private funds for silvopasture and forest farming
- **Get Shade. Get Paid.** https://www.workingtrees.com/assets
  - USDA Conservation Innovation Grant funds and carbon credits for silvopasture
- **Expanding Agroforestry Production** https://www.nature.org/en-us/what-we-do/our-priorities/provide-food-and-water-sustainably/expanding-agroforestry-production/?vu=expandingagroforestry
  - USDA Climate Smart funds for alley cropping, windbreaks, and silvopasture (NRCS standards)
- **Grassland Partnership** (in "fescue belt" counties) https://grasslandspartnership.org/
  - USDA Climate Smart funds for improved grazing management, soil amendments, legumes, silvopasture, native grasses, and perennial field borders
- **Grazing for Appalachian Sustainability (GRASS)** (in Appalachian counties) https://extension.wvu.edu/agriculture/pasture-hay-forage/grazing-for-appalachian-sustainability
  - USDA Climate Smart funds for improved grazing management, nutrient management, pasture and hay planting, silvopasture, and access to forage finished beef markets
- **NRCS-EQIP Cost Share**
  - Cost share funds for practice 381: Silvopasture establishment in open field

References

Beegle, D., J. Fike, J. Munsell. 2024. Tree Selection Guide for Mid-Atlantic Silvopastures. https://www.pubs.ext.vt.edu/content/pubs_ext_vt_edu/en/SPES/spes-476/spes-476.html

Fike, J., A. Downing, and J. Munsell. 2016. Defining silvopastures: Integrating tree production with forage-livestock systems for economic, environmental, and aesthetic outcomes https://www.pubs.ext.vt.edu/CSES/CSES-146/CSES-146.html

Fike, J., A. Downing, J. Munsell, J. Daniel, C. Teutsch, K. Mercier, G. Pent. 2021. Creating Silvopastures: Some Considerations When Thinning Existing Timber Stands. https://www.pubs.ext.vt.edu/CSES/CSES-155/CSES-155.html

Fike, J., A. Downing, J. Munsell, G. Frey, K. Mercier, G. Pent, C. Teutsch, J. Daniel, J. Fisher, T. Groh. 2023. Creating Silvopastures: Some Considerations When Planting Trees in Pastures. https://www.pubs.ext.vt.edu/CSES/CSES-185P/CSES-185.html

Pent, G., A. Downing, J. Fike. 2020. Establishing & Protecting Trees in Pastures. In: Proceedings of Shenandoah Valley Agriculture Research and Extension Center Field Day. https://www.arec.vaes.vt.edu/content/dam/arec_vaes_vt_edu/shenandoah-valley/research/field-day/documentation/2020%20Field%20Day%20Proceedings.pdf

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NATIVE WARM SEASON GRASS GRAZING EVALUATION AND VARIETY TRIAL

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Introduction

While tall fescue (*Schedonorous arundinaceus*) is the predominant forage species in Virginia pasture systems, this cool-season grass has limited productivity during the summer months. In addition, most of the tall fescue in Virginia is infected with an endophyte that produces ergot alkaloids. These alkaloids can be toxic to livestock and induce vasoconstriction in cattle, which reduces their ability to regulate their body temperature. As a result, many livestock in Virginia experience severe heat stress during the summer months, resulting in impaired productivity and welfare. These stressed livestock often seek relief from heat within sensitive woodlands, surface waters, and riparian areas; thus, toxic tall fescue is at least partially responsible for woodland degradation and water impairment. Toxic endophyte-infected tall fescue also causes reproductive issues in pregnant mares including retained placentas, dystocia, and agalactia.

Tall fescue forms a dense sod, which is unconducive to travel by ground nesting birds, such as the bobwhite quail, a target species of the Working Lands for Wildlife (WLFW) partnership. The lack of appropriate habitat has been cited as a significant factor in the rapid decline in bobwhite quail (*Colinus virginianus*) numbers across Virginia.

Unlike cool-season grasses, which grow predominately in the spring and fall, warm-season grasses are most productive during summer months and have the potential to fill a large forage production gap in the southeastern US, known as the "summer slump." Native warm season grasses (NWSG) are well-adapted to this region's climate and soils, maintaining high productivity even in the summer months and with minimal inputs, in part because their roots can

Figure 1. Cattle grazing a productive pasture of native warm season grasses during the middle of summer.

exploit water resources at greater depths than cool-season grasses. Their deep rooting potential also has value for carbon sequestration.

In addition to offering these production benefits and ecosystem services, NWSG have an important role to play in wildlife conservation. The robust, upright form and open space between plants in a NWSG stand provides the type of habitat required for foraging and nesting by bobwhite quail and other ground nesting birds. These grasses shelter small mammals and birds from predators, even after heavy snow events when left standing overwinter.

Native warm season grasses can provide food for livestock and wildlife alike. Under proper management, NWSG provide highly nutritious forage and can persist in pastures indefinitely. Unfortunately, their adoption has been minimal. Lack of familiarity, historic challenges with establishment, and misperceptions and uncertainty surrounding nutritional quality and stand management largely account for farmer reluctance to adopt NWSG in Virginia. The purpose of this publication is to report on a successful conversion to NWSG, as well as the utilization of these grasses for several years following establishment.

Grazing demonstration

Conversion: Site selection, preparation, and establishment

A grazing system at Virginia Tech's Southern Piedmont Agricultural Research and Extension Center (SPAREC) in Blackstone, Virginia provides forage resources for various stocker cattle grazing research and demonstration projects. While the tall fescue present in this grazing system is entirely novel endophyte, the principles and process when converting a toxic endophyte-infected tall fescue field to NWSG would not differ from the practices utilized in this project.

A 16-acre field was identified at SPAREC for conversion. This field had some weed issues that needed to be controlled, and the land slope and soil type were conducive to renovation.

The key to successful conversion of cool-season grass pastures to NWSG is multiple application of herbicides for effective sod and weed control. These applications should be timed across multiple seasons to ensure that all categories and types of weeds are effectively controlled.

This project started in October of 2018 with an application of glyphosate (2 qt/ac plus surfactant). Cereal rye (Secale cereale) was seeded (1.5 bushel/ac) in late November as a cover and potential forage crop. This rye was eventually grazed by a small herd of cattle from May 9-20, 2019. No fertilizer or lime were applied throughout the duration of this conversion process (with the exception of a small amount of lime used as a seed carrier during seeding the native grasses).

Following grazing, the field was left fallow through the summer of 2019. The original plan was to seed the NWSG at this point, but due to unforeseen circumstances, this seeding was delayed. However, this delay helped provide for additional weed control. The fallow ground was maintained with a rotary mower through the summer (July), and some woody broadleaf weed species were spot-sprayed with a mixture of Remedy (1 qt/ac) and Cimarron (0.01 oz/ac). The field was sprayed with glyphosate (2 qt/ac) in mid-July.

In mid-August, 2019, the field was sprayed again with glyphosate (2 qt/ac) and Remedy (1 qt/ac). Barley (*Hordeum vulgare*, 60 lb/ac) was seeded into the field on October 15 as a cover crop. The barley was terminated with glyphosate (0.5 qt/ac) on February 24, 2020, with the NWSG seed mixture planted on March 17, 2020.

This mixture included 5 lb/ac of 'Niagara' big bluestem (*Andropogon gerardii*), 3 lb/ac of 'Georgia ecotype' indiangrass (*Sorghastrum nutans*), and 2 lb/ac of 'Camper' little bluestem (*Schizachyrium scoparium*). All seed rates were corrected for pure live seed (PLS), and all of the seed was donated for this project by Ernst Conservation Seeds (Meadville, PA). Pelletized lime was utilized as a carrier for this fluffy seed, and the seed was planted with a Truax drill using the native grass seed box equipped with agitators to keep the seed flowing. The seed was planted at a targeted ¼" depth. The drill was calibrated to plant at half of the desired seeding rate, and the seed was cross planted by running the drill across the field twice.

Ten days following planting, Plateau herbicide (4 oz/ac) was sprayed over the field to control summer annual grassy weeds. The three NWSG species planted into the field are tolerant of this particular herbicide, but other native grasses, including switchgrass (*Panicum virgatum*) and Eastern gamagrass (*Tripsacum dactyloides*) are not tolerant of the active ingredient in this herbicide, imazapic. This herbicide provides effective pre-germination control of many summer annual grassy weeds, which are a substantial threat to the successful establishment of NWSG, for a couple months following application, depending on the weather.

Figure 2. Native warm season grass seedlings germinating in May 2020.

While the weedy grasses were effectively controlled by the Plateau herbicide application, a substantial amount of marestail (*Erigeron canadensis*) germinated and eventually outgrew the young NWSG seedlings.

Once these young grass seedlings had grown to the point of tillering in early July, an herbicide application of Duracor (12 oz/ac) and Cimmaron Plus (0.125 oz/ac) was sprayed on the field. This largely eliminated the broadleaf weed competition within a few weeks.

The NWSG field was then left to senesce and enter dormancy naturally. The field was mowed with a rotary mower in January to remove the tall, standing dead herbage. The field was also divided into four, equally-sized paddocks for rotational stocking management. A nearby 16-acre field of tall fescue was also similarly fenced into four paddocks for a grazing systems comparison.

Figure 3. Native warm season grass seedlings were evident in early summer of the establishment year, but there was also substantial broadleaf weed germination and cover (left). The native warm season grass stand had grown substantially by the end of the establishment growing season in August 2020 (right).

Stocking management and methods

The purpose of this project was to demonstrate and compare cattle performance on NWSG pastures to cattle performance on novel endophyte tall fescue pastures. While this demonstration project is not considered a replicated study with broad applicability, we believe that this case study provides farmers with some performance goals that they might expect out of fields converted to NWSG.

In the first stocking year (2021), 32 weaned steers from the Shenandoah Valley Agricultural Research and Extension Center (SVAREC) were used for an analysis of animal performance (average daily gains) on NWSG compared to animal performance on novel endophyte tall fescue.

Steers were weighed twice over a two-day period at the beginning and the end of the project to account for daily variations in body weight. The difference in starting and ending weight was divided by the total time on a given pasture to determine average daily gains for each treatment. Forage samples were collected for an analysis of forage availability and post-graze residual before and after every rotation to a new paddock. Forage from ten 1-ft^2 quadrats was harvested at random locations throughout the paddock during each sampling event. The NWSG were harvested to a height of 10", and the tall fescue was harvested to a height of 4". In addition to dry weight, the samples were analyzed for crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF) using near infrared spectroscopy (NIRS).

Table 1. Grazing initiation and rotation dates during the 2021 and 2022 growing season.

	2021	2022	2023
Initiation	June 11	May 11	May 9
Rotation 1	July 8	June 9	June 16
Rotation 2	Aug. 6	July 7	July 20
Rotation 3	Sept. 2	July 29	Sept 6

In 2021, the steers on each type of forage were rotated to a fresh paddock on or around every seven days. The steers were stocked on the pasture on June 11, and each paddock in the grazing systems was grazed three times through the summer. Due to a high forage availability, 20 steers were stocked on the NWSG at the start of the grazing season, while 12 steers were stocked on the tall fescue pastures. However, the stocking on the NWSG was reduced to 12 steers on July 8. Due to the late start to grazing that season, much of the NWSG was mature and was subsequently trampled by the steers, resulting in slower regrowth after the first rotation.

In 2022, steers were sourced from the same farm and the pastures were managed similarly to year one. The project also began about one month earlier in year two. Sixteen steers were stocked on each pasture on May 11. The steers were stocked on each paddock three times for about seven days per paddock. However, due to a drought, the steers were pulled from these treatment pastures one week early, at which point the study was concluded for the year.

While the stocking methods employed in the first two years allowed for a reasonable comparison of average daily gains across two types of pastures, the true carrying capacity or animal grazing days produced on an area basis could not be determined with this arrangement. Thus, in the third year of the project, 32 steers were managed in a single herd, all of the four-acre paddocks were split in half, and the larger herd was stocked on these paddocks for 3-4 days or until an insufficient forage threshold was reached. Steers were removed from NWSG pastures between July 3 and July 20, 2023 to allow for adequate pasture regrowth.

Forage and steer productivity

Steer grazing days in 2021 were higher for the first rotation due to the greater stocking rate. However, even with the greater stocking rate, the forage was underutilized and the steers trampled a substantial portion of the NWSG.

Forage yield was also greater for the NWSG than the tall fescue early in 2022, but in both years, the NWSG had slowed substantially in growth by the end of the season, with similar forage yield to the tall fescue. The tall fescue had more protein and lower fiber than the NWSG, but this did not translate to a difference in animal performance.

Table 2. Forage dry matter (DM) yield (lb DM/acre) of native warm season grass and novel tall fescue during each rotation of the 2021-2023 grazing seasons in Blackstone, VA.

Forage Type	**Rotation 1**	**Rotation 2**	**Rotation 3**
2021			
NWSG	4,233	1,697	1,036
Novel Tall Fescue	1,283	1,142	945
2022			
NWSG	2,224	2,654	560
Novel Tall Fescue	1,120	1,098	514
2023			
NWSG	2,935	2,066	2,682

Table 3. Crude protein content (%) of native warm season grass and novel tall fescue during each rotation of the 2021-2023 grazing seasons in Blackstone, VA.

Forage Type	**Rotation 1**	**Rotation 2**	**Rotation 3**
2021			
NWSG	9.3	12.3	14.0
Novel Tall Fescue	12.2	14.7	14.7
2022			
NWSG	13.0	11.1	10.3
Novel Tall Fescue	12.5	11.6	10.6
2023			
NWSG	14.3	12.8	11.3

Table 4. Neutral detergent fiber content (%) of native warm season grass and novel tall fescue during each rotation of the 2021-2023 grazing seasons in Blackstone, VA.

Forage Type	**Rotation 1**	**Rotation 2**	**Rotation 3**
2021			
NWSG	66.9	64.4	60.5
Novel Tall Fescue	59.3	56.2	55.4
2022			
NWSG	60.5	63.0	63.7

Novel Tall Fescue	61.6	65.1	67.0
2023			
NWSG	58.2	64.2	65.2

Table 5. Acid detergent fiber content (%) of native warm season grass and novel tall fescue during each rotation of the 2021-2023 grazing seasons in Blackstone, VA.

Forage Type	Rotation 1	Rotation 2	Rotation 3
2021			
NWSG	36.2	33.2	29.6
Novel Tall Fescue	31.0	29.4	28.8
2022			
NWSG	36.1	38.7	38.7
Novel Tall Fescue	34.6	37.0	38.0
2023			
NWSG	36.2	38.1	39.3

In both years, steer performance was very good compared to what might be expected when stocked on a toxic endophyte-infected tall fescue pasture during the summer. There was little difference in steer average daily gains in both years on both types of pastures. When converted to gain per acre, the NWSG pastures produced more liveweight gains over the summer season than the tall fescue pastures. (Note that these data are observational only and do not indicate statistically evaluated comparisons.)

Table 6. Daily gain (lb/day) of steers grazing native warm season grass or novel tall fescue during each rotation of the 2021-2023 grazing seasons in Blackstone, VA.

Forage Type	Rotation 1	Rotation 2	Rotation 3
2021			
NWSG	0.91	1.43	1.68
Novel Tall Fescue	1.23	1.45	1.64
2022			
NWSG	3.50	1.31	1.36
Novel Tall Fescue	3.28	0.65	1.44
2023			
NWSG	2.42	1.09	1.27

Due to the varied stocking rate, the best comparison of animal performance would be adjusted to a measure of yield per unit area. In 2021, the NWSG pastures yielded 93 lb of cattle weight gain per acre, while the novel tall fescue pastures yielded 83 lb of weight gain per acre. In 2022, the NWSG pastures yielded 154 lb of weight gain per acre, while the novel tall fescue pastures 132 lb weight gain per acre. When the NWSG pastures were stocked more densely in 2023, the gains per acre increased substantially to 320 lb of cattle weight gain per acre for the season.

Grazing demonstration conclusions

When converting a field of cool-season grasses to NWSG, proper planning and preparation is key to establishment success. Multiple sprays and clean seedbed preparation will help minimize weed competition in the establishment year. The strategic and repeated use of herbicides will also help minimize competition.

Once established, these NWSG can be very productive. For improved utilization and grazing efficiency, it is important to start grazing these grasses before they become overly mature in the spring and to maintain heavy, but flexible stocking densities depending on the weather and forage growth.

While the establishment period of converting pastures to NWSG is relatively long compared to establishing annual forages, once established these grasses are very productive and can result in an excellent summer grazing resource for farmers in Virginia. As this demonstration indicated, growing cattle on NWSG can have similar average daily gains to cattle on novel endophyte tall fescue, while the potential for higher stocking rates during the summer months on NWSG can result in greater levels of animal gain per unit of area compared to cool season forage-based pastures.

Forage variety trial

The purpose of this variety trial was to determine the regional productivity of various NWSG cultivars or ecotypes of four different species of native grasses: big bluestem, eastern gamagrass, indiangrass, and switchgrass.

This trial was established in 2020 at five locations across Virginia. These locations encompass the dominant hardiness zones (Figure 4) and physiographic provinces of Virginia. Soil types and test result values for each location are reported in Appendices 1-5 in the full variety trial publication located at: https://www.pubs.ext.vt.edu/content/pubs_ext_vt_edu/en/SPES/spes-562/spes-562.html.

A map of the variety trial plots is shown in Appendix 1. The five locations of this variety trial were:

1. Middleburg Agricultural Research and Extension Center, Middleburg, Virginia
2. Shenandoah Valley Agricultural Research and Extension Center, Raphine, Virginia
3. Southern Piedmont Agricultural Research and Extension Center, Blackstone, Virginia
4. Southwest Agricultural Research and Extension Center, Glade Spring, Virginia
5. Tidewater Agricultural Research and Extension Center, Suffolk, Virginia

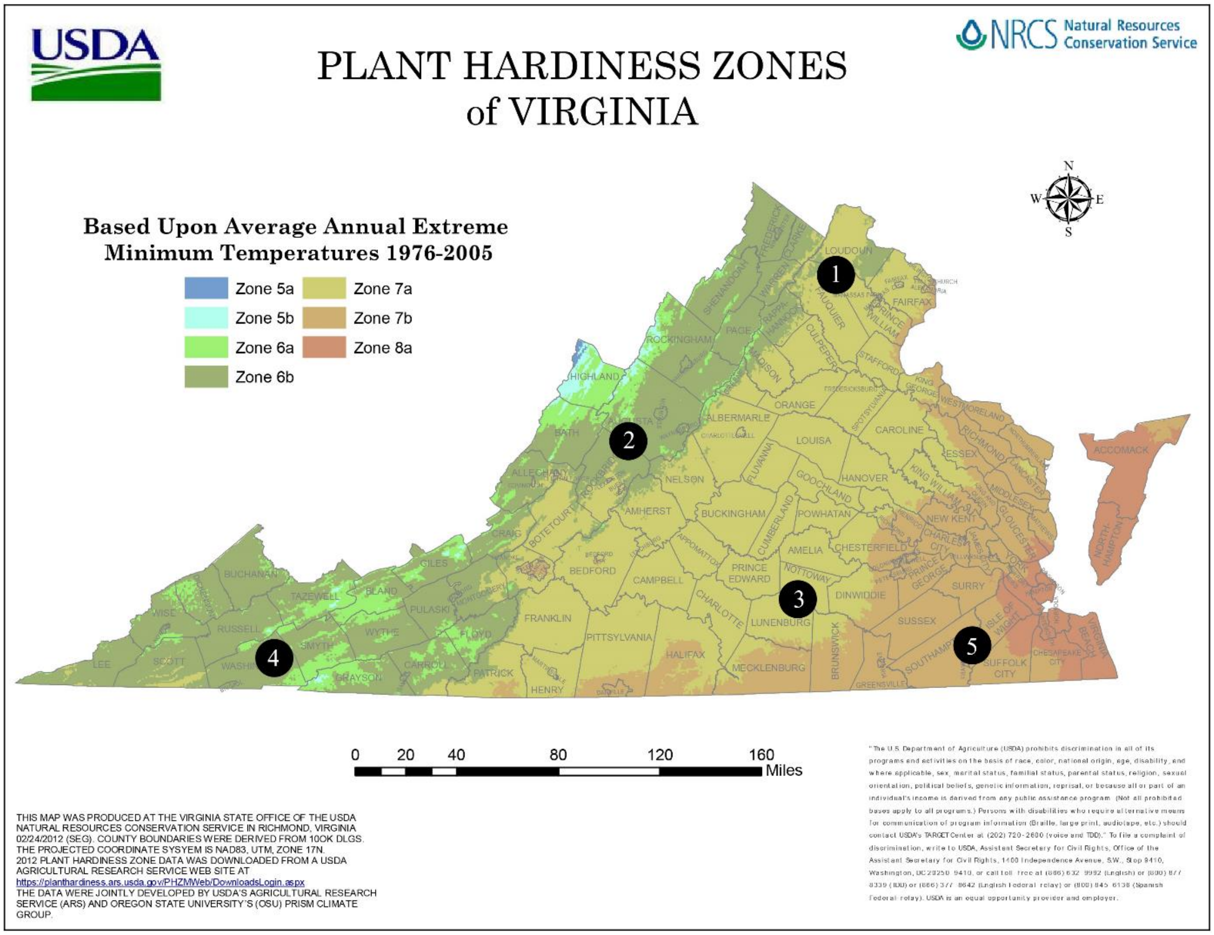

Figure 4. County and hardiness zone map of Virginia showing locations of native warm season grass variety trial. The numbers correspond to the location list in the text. Map accessed from https://efotg.sc.egov.usda.gov/references/public/va/PlantHardiness.pdf.

Establishment

A mixture of glyphosate (41%) at 2 qt/ac and 0.5% nonionic surfactant was sprayed on plot areas the fall prior to seeding, except for the Middleburg location which was sprayed one week prior to seedbed preparation. Seedbeds were prepared for planting through discing following by harrowing or rototillage. The plots were then rested for a minimum of one week to allow the soil to settle, with the exception of the Raphine location which was cultipacked immediately following tillage.

Plot sizes were six by ten feet with four replications per cultivar. A Carter forage plot seeder was used to seed all of the species except the eastern gamagrass, which was planted with a single row push corn planter in four strips per plot due to the large seed size of this species. Seeding depth was less than ¼” of an inch for all of the species except the eastern gamagrass, which was planted at ¾-1” depth. All cultivars were planted on a pure live and non-dormant seed basis with 9 lb/ac for the big bluestem, 14 lb/ac for the eastern gamagrass, 9 lb/ac for the indiangrass, and 6 lb/ac for the switchgrass. A fixed amount of pelletized lime was used as a carrier for all of the species and varieties. All plots were sprayed again with a mixture of glyphosate (41%) at 2 qt/ac and 0.5% nonionic surfactant at planting.

Plots were established on the following dates: May 27, 2020: Blackstone; June 2, 2020: Glade Spring; June 11, 2020: Raphine; June 24, 2020: Suffolk; July 14, 2020: Middleburg

Rainfall from May through July at each location was within 1.5" of the 30-year precipitation mean for those three months. Approximately two months following planting, plots at all locations except for Blackstone were clipped with a rotary mower to remove weed biomass above the native grass seedlings. The mower was set to a height at or above the tallest height of the native grasses.

Germination evaluation, harvest management, and statistical analysis

Seedling germination was evaluated around sixty days following establishment at Raphine and Blackstone. A 0.5 m^2 quadrat was placed directly in the center of each plot, and the number of native grass seedlings was counted within the quadrat. Seedling count by cultivar was compared within a species using PROC MIXED in SAS Studio, v. 9.4 (SAS Inst., Cary, NC). Differences were considered significant when $P \leq 0.05$ and as trends when $0.05 < P \leq 0.10$.

Plots were harvested once in 2021 at Raphine, Blackstone, and Suffolk. Plots were harvested twice in 2022 at those three locations and once at Middleburg. Plots were harvested once in 2023 at Middleburg and Glade Spring and twice at Raphine, Blackstone, and Suffolk. No fertilizer or soil amendments were applied to the plot area at any location for the duration of this test. After each harvest, all biomass was removed from the plots. The monthly precipitation for the county where each trial was located is presented in Appendix 6. Plots were sprayed with 3 qt/ac pendimethalin (38.7%), 1 qt/ac glyphosate (41%) or 1 qt/ac triclopyr (60.5%), and 0.5% non-ionic surfactant in April 2022 to reduce weed competition at all locations.

Cutting height was set to 5" for all plots at harvest. Total biomass harvested from the plot area was recorded, and a subsample was collected for dry matter corrections. The subsamples were dried in a forced oven at 135 °F for a minimum of four days before weighing. The dry matter correction was applied to the total fresh plot weight to calculate dry matter yield per unit area. Prior to harvest, percent cover of the cultivar and the weed pressure by type of weed (grass, broadleaf, and sedge) was scored in each plot using a modified Daubenmire ranking scale (1: 0-5.0% cover; 2: 5.1-25.0% cover; 3: 25.1-50.0% cover; 4: 50.1-75.0% cover; 5: 75.1-95.0% cover; 6: 95.1-100.0% cover). Forage dry matter yield by cultivar was compared within a species using PROC MIXED in SAS Studio, v. 9.4 (SAS Inst., Cary, NC). Locations were analyzed separately for the tables presented in the appendices. Differences were considered significant when $P \leq 0.05$ and as trends when $0.05 < P \leq 0.10$.

Results: Germination

Seedling count by cultivar is shown in Table 7. There tended to be a treatment (cultivar) by location interaction (P=0.0642). Some cultivars had lower germination than others, but by the second year, these differences had an indistinguishable effect on yield, likely due to germination of dormant seed and tillering of seedlings in the first year.

Table 7. Seedling count by cultivar at Raphine and Blackstone locations 60 days following planting (BB: big bluestem; EG: eastern gamagrass; IG: indiangrass; SG: switchgrass)

Species	**Cultivar**	**LSM**[1]	**SE**[2]
BB	Niagara	9.0	1.6
BB	KY Ecotype*	1.0	1.6
BB	Kaw	5.9	1.6
BB	Pawnee	6.3	1.6
EG	Highlander*	1.4	0.7
EG	Iuka IV	4.7	0.7
EG	Pete	3.6	0.7
IG	Cheyenne	6.2	1.9
IG	NC Ecotype	6.2	1.9
IG	Rumsey	7.0	1.9
IG	KY Ecotype	9.3	1.9
IG	Osage	8.7	1.9
IG	GA Ecotype*	0.8	1.9
IG	Holt	9.3	1.9
SG	Shawnee*	5.7	3.9
SG	Cave-in-Rock*	6.3	3.9
SG	Performer	11.2	3.9
SG	BoMaster	10.3	3.9
SG	Alamo	19.7	3.9
SG	Carthage**	9.1	3.9

[1] Least significant means
[2] Standard error
* Count was significantly different from the highest numerical value within the same species based on 0.05 LSD
** Count tended to be significantly different from the highest numerical value within the same species based on 0.10 LSD

Results: Forage yield

Seasonal yields (sum of all of the harvests at a location each year) were analyzed within a species across all five locations. There was no treatment (cultivar) by location interaction for any of the species ($P>0.05$). However, there tended to be treatment by location interaction for indiangrass ($P=0.0964$).

Mean seasonal yields for each cultivar are presented as averages across all locations in Table 8. There were no significant differences in yields of cultivars within a species. However, cultivar tended to have a significant effect in the comparison of indiangrass due to the poor germination and growth of two cultivars, 'NC ecotype' and 'GA ecotype.' For these two cultivars, some of the plots were not harvested due to absence of the cultivar of interest.

Table 8. Seasonal yield (ton/acre) by cultivar across five locations in Virginia and over three seasons (BB: big bluestem; EG: eastern gamagrass; IG: indiangrass; SG: switchgrass; Non-est: non-estimable)

Species	**Cultivar**	**LSM[1]**	**SE[2]**
BB	Niagara	2.4	0.8
BB	KY Ecotype	2.5	0.8
BB	Kaw	2.2	0.8
BB	Pawnee	2.0	0.8
EG	Highlander	3.4	1.2
EG	Iuka IV	3.1	1.2
EG	Pete	3.4	1.2
IG	Cheyenne	2.4	0.6
IG	NC Ecotype	Non-est	Non-est
IG	Rumsey	2.3	0.6
IG	KY Ecotype	2.4	0.6
IG	Osage	2.3	0.6
IG	GA Ecotype	Non-est	Non-est
IG	Holt	1.8	0.6
SG	Shawnee	3.7	1.3
SG	Cave-in-Rock	3.8	1.3

SG	Performer	3.4	1.3
SG	BoMaster	3.9	1.3
SG	Alamo	3.9	1.3
SG	Carthage	3.7	1.3

[1] Least significant means
[2] Standard error

Although differences were not analyzed across species, it may be useful to note the greater yields of switchgrass and eastern gamagrass compared to big bluestem and indiangrass. While the two former species do in general produce more biomass than the two latter species, the yield data presented here are likely biased towards switchgrass and eastern gamagrass because they are earlier maturing species. Due to all species and plots within a location harvested on a single date once or twice a year, the earlier maturing species would indicate greater yields than the later maturing species. Farmers considering certain species for selection should consider nutritive value and palatability, however, not just forage yield.

Seasonal yields are also presented by year for the Shenandoah Valley AREC in Appendix 2. (Additional forage yield data from the other locations are available in the full publication.) Plots with insufficient cover of the target cultivar for a reliable estimation of yield within the plot were not harvested. Poor establishment of some species at some locations (e.g. indiangrass at Middleburg) resulted in very high standard errors. Thus, caution should be taken when evaluating the results for these species at these locations.

Germination and eventual productivity of indiangrass ecotypes (‘GA ecotype’ and ‘NC ecotype) were lower than for the other cultivars and ecotypes at four of the locations. This was a common pattern across all locations with the exception of Glade Spring, where indiangrass productivity was poor across cultivars and ecotypes due to poor establishment at this site.

Ecotypes are defined as seeds from an unimproved selection of seed from a given area. These varieties are thought to be better adapted to the region from which they were selected due to their extended period of evolution in that region. Cultivars, however, are improved lines of plants developed through selective breeding processes to target specific desired characteristics. These characteristics may include growth, forage nutritive value, and diseases resistance. As a result, improved cultivars often, but not always, may be expected to be higher yielding than ecotypes.

Variety trial conclusions

While this project yielded a substantial amount of information on the productivity of various cultivars and ecotypes of NWSG across Virginia, it also reinforced a few points that may be helpful for someone interested in establishing these grasses for forage or wildlife goals.

Germination of these perennial species can be slow, especially compared to the growth of nonnative annual weeds. Weed control through advanced site preparation and follow-up herbicide or mechanical control is imperative for the success of the planting. In addition, full productivity of these species may not be realized until two seasons following establishment.

Once these species are established, they can be very productive, even without fertilizer or lime applications. In the case of this variety trial, no soil amendments were applied to the plots despite the removal of biomass from the plots following each harvest. In a grazing system, these nutrients would be largely recycled through the grazing animals and thus very little soil amendments would be necessary for the optimum productivity of these species. In a hay production system where the vegetation is removed from the field year after year, it would be advantageous to follow soil test nutrient recommendations when applying fertilizer and lime.

In general, the cultivars matured in the following order: eastern gamagrass, switchgrass, big bluestem, and indiangrass. This may be helpful information when selecting a species based on when forage is most needed and to prevent growing season overlap with the rest of the forage system. It is also not recommended to mix eastern gamagrass or switchgrass with plantings of the other species due to their more rapid rates of maturity. If a mixture of species is desired for forage production purposes, it is helpful to pair species and cultivars together with similar maturity rates so that harvest can be more appropriately timed to the needs of the crop.

Greater biomass yields may be useful in some contexts (maximizing yield for forage and biomass production purposes), but in some situations, such as in wildlife or conservation plantings, too much biomass may not be advantageous. In wildlife habitat plantings, a thinner grass sward may be more beneficial to small birds and mammals building nests and burrows within the stand. In these situations, ecotypes may be a better choice.

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Appendix 1. Native warm season grass variety trial plot plan.

Row 4		Row 3		Row 2		Row 1	
KY Ecotype	IG	NC Ecotype	IG	Iuka IV	EG	Alamo	SG
Rumsey	IG	KY Ecotype	IG	Osage	IG	BoMaster	SG
Cheyenne	IG	Pete	EG	Highlander	EG	KY Ecotype	BB
Performer	SG	Iuka IV	EG	Niagara	BB	Pete	EG
Niagara	BB	Highlander	EG	Holt	IG	Iuka IV	EG
Cave-in-Rock	SG	Cheyenne	IG	Carthage	SG	NC Ecotype	IG
Alamo	SG	Kaw	BB	Cave-in-Rock	SG	Cheyenne	IG
Pawnee	BB	Holt	IG	KY Ecotype	BB	Pawnee	BB
Iuka IV	EG	Carthage	SG	BoMaster	SG	KY Ecotype	IG
Holt	IG	Rumsey	IG	NC Ecotype	IG	Performer	SG
KY Ecotype	BB	Performer	SG	Pete	EG	Niagara	BB
Shawnee	SG	GA Ecotype	IG	Kaw	BB	Highlander	EG
Carthage	SG	Niagara	BB	Performer	SG	Cave-in-Rock	SG
Kaw	BB	Alamo	SG	KY Ecotype	IG	Holt	IG
BoMaster	SG	Osage	IG	GA Ecotype	IG	Rumsey	IG
High-lander	EG	Shawnee	SG	Pawnee	BB	Osage	IG
Pete	EG	BoMaster	SG	Cheyenne	IG	GA Ecotype	IG
Osage	IG	KY Ecotype	BB	Shawnee	SG	Kaw	BB
GA Ecotype	IG	Cave-in-Rock	SG	Alamo	SG	Shawnee	SG
NC Ecotype	IG	Pawnee	BB	Rumsey	IG	Carthage	SG

Appendix 2. Seasonal yield (ton/acre) by cultivar at the Shenandoah Valley AREC in Raphine, Virginia over three seasons. Maturity rankings were collected at the first harvest of each year, and the maturity ranking was reported with the greatest number of plots recorded at that ranking. Plots at this location were harvested once in 2021 (November 5), twice in 2022 (June 29 and August 31), and twice in 2023 (July 11 and September 6).

Species[1]	Cultivar	2021		2022			2023		
		LSM[2]	SE[3]	LSM[2]	SE[3]	Maturity[4]	LSM[2]	SE[3]	Maturity[4]
BB	Niagara	0.5	0.2	3.5	0.3	V	2.1	0.3	R2
BB	KY Ecotype	0.3	0.2	3.5	0.2	V	2.4	0.2	V
BB	Kaw	0.2	0.2	4.0	0.2	V	2.8	0.2	E
BB	Pawnee	0.4	0.2	3.2	0.3	V	2.8	0.4	V
EG	Highlander	0.7	0.7	5.6	0.7	E	5.9	0.7	S
EG	Iuka IV	0.9	0.7	5.2	0.7	R3	5.9	0.7	S
EG	Pete	0.7	0.7	6.2	0.7	R3	6.8	0.7	S
IG	Cheyenne	0.8	0.3	4.6	0.4	V	2.5	0.4	V
IG	NC Ecotype	0.7	0.3	3.4*	0.4	V	1.3*	0.4	V
IG	Rumsey	0.6	0.3	4.7	0.3	V	2.7	0.4	V
IG	KY Ecotype	0.7	0.3	4.4	0.4	V	2.7	0.4	V
IG	Osage	0.9	0.3	4.8	0.3	V	2.6	0.4	V
IG	GA Ecotype	0.2	0.3	1.5*	0.3	V	0.7*	0.6	V
IG	Holt	0.5	0.3	4.8	0.3	V	3.1	0.4	V
SG	Shawnee	0.5	0.5	7.1	0.5	E	3.8	0.5	R1
SG	Cave-in-Rock	0.6	0.5	6.6**	0.5	E	3.6	0.5	R1
SG	Performer	0.9	0.5	7.3	0.5	E	2.3*	0.5	E
SG	BoMaster	0.8	0.5	7.8	0.5	E	2.3*	0.5	E
SG	Alamo	1.3	0.5	6.9	0.5	E	1.9*	0.5	E
SG	Carthage	0.5	0.5	5.1*	0.5	E	2.9	0.5	R1

[1] Species: BB = big bluestem, EG = eastern gamagrass, IG = indiangrass, SG = switchgrass
[2] Least significant means
[3] Standard error
[4] Maturity ranking: V = vegetative, E = elongating, R1 = boot stage, R2 = fully emerged, R3 = anthesis, S = mature seed
* Yield was significantly different from the highest numerical value within the same species based on 0.05 LSD
** Yield tended to be significantly different from the highest numerical value within the same species based on 0.10 LSD

BIODIVERSE FORAGE MIXTURES FOR BEES AND BEEF CATTLE AND ESTABLISHING NATIVE WARM SEASON GRASSES

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Most pastures in Virginia are dominated by tall fescue (*Schedonorus arundinaceus*), and lack substantial plant diversity. Planting native warm-season grasses (NWSGs) and wildflowers (WFs) into these pastures could provide summer forage for cattle and more floral resources for pollinators. In a pasture production context, an ideal mixture of NWSG-WF should provide sufficient forage supply to sustain cattle and abundant blooms for that will attract pollinators to supply them with food resources. A challenge is how best to plant these NWSG and WF mixtures to ensure a favorable balance between the components since each provides different benefits to the pasture ecosystem. To address this issue, three small plot experiments were conducted at SVAREC from 2021 to 2023 to evaluate different planting methods designed to optimize establishment of NWSG-WF stands (Figure 1).

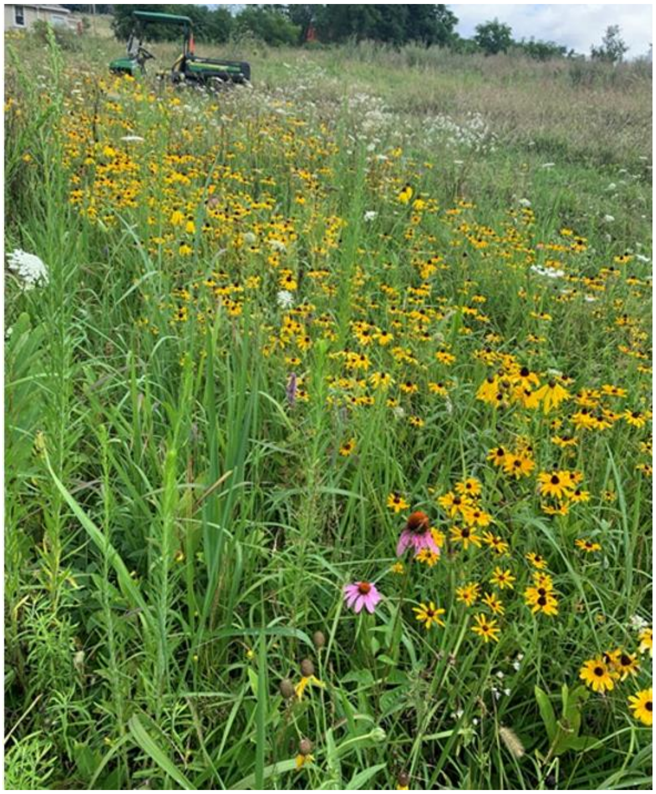

Figure 1. Plot in one of the SVAREC experiments evaluating establishment methods for native grasses and wildflower mixtures.

The three field experiments involved planting NWSG and WF mixtures in different temporal and spatial configurations – e.g., side by side vs mixed together or separated in time where NWSG or WF were planted in difference sequences. Experiments were also done to examine whether the ratio of NWSG to WF in planted mixtures affected establishment. A third experiment evaluated the use of different companion crops such as buckwheat to see if their inclusion in mixtures helped with establishment of NWSG and WFs by suppressing weeds.

The most promising results came from the spatiotemporal experiments. Results showed few differences in forage mass, floral production, and botanical composition early on, but by 2023 NWSG abundance was greater where grasses were planted first. Similarly, the WF component was favored when they were planted before NWSGs. Overall, planting NWSG and WF mixes separately, either spatially or temporally, favored more successful establishment and could offer valuable flexibility for use of selective herbicides to suppress the heavy weed pressure that often accompanies these plantings. Major findings from the other experiments suggested that varying the ratio of NWSG-WF in seed mixtures produced similar establishment outcomes, and that adding companion crops to NWSG-WF mixtures did not improve establishment success appreciably.

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