

**Evaluation of Forage Nutritive Value and
Dry Matter Yield of Stockpiled Tall Fescue
Across Plant Hardiness Zones 7 and 8**

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Malerie Elizabeth Fancher
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ABSTRACT

Pastures in Tennessee comprise mainly tall fescue [*Schedonorus arundinaceus* (Schreb.) Dumort.], a cool-season perennial grass. Tennessee producers feed hay for an average of 143 days per year, there is interest in utilizing stockpiling to extend the grazing season. Although this practice has been proven to reduce hay needs (Freeman et al., 2019), it is vital to maintain up-to-date recommendations using data from across the southeastern US to inform nutritional management decisions. The objective of this study is to determine the nutritive value and dry matter yield of stockpiled tall fescue across plant hardiness zones 7 and 8. Fourteen farms across Tennessee and Alabama were identified as sampling sites. In September 2021, three exclusion cages (4 ft × 4 ft) were constructed at each site, forage was clipped to a 2-inch height, and plots were fertilized at a rate of 60 lb. N/ac. During years 2021-2022 and 2022-2023, samples were clipped at a 2-inch height from a 1 ft² quadrat monthly from October through February. Data were analyzed using PROC GLIMMIX for a completely randomized design. Results indicate that plant hardiness zone did not have a significant effect on forage yield ($P = 0.2098$). Dry matter yield increased over the length of the stockpiling period ($P < 0.0001$) from 2,354 lbs. DM/ac to 4,391 lbs. DM/ac. Crude protein (CP) and total digestible nutrients (TDN) concentrations decreased ($P < 0.0001$ and $P = 0.0358$, respectively) throughout the stockpiling period; however, ranges were still within those needed to support the nutritional needs of a lactating cow with CP ranging from 15 – 17% and TDN ranging from 68 – 70%. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) concentrations increased over the stockpiling period ($P = 0.0029$ and $P = 0.0145$, respectively) as plants mature. Results from this study conclude that stockpiled tall fescue in plant hardiness zones 7 and 8 can support the nutritional requirements of mature cows at all stages of production through winter months. Results will be used to inform Extension recommendations to assist producers in making management decisions that increase grazing days and reduce supplemental feed input costs.

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CHAPTER ONE

INTRODUCTION AND GENERAL INFORMATION

Introduction

The Fescue Belt is a region of the southeastern United States most commonly known for its ability to support growth of a variety of forage species, regardless of growing season. Cattle producers in the Southeast US can capitalize on a wider variety of available forage during the grazing season to support the nutritional needs of cattle. Although traditional hay preservation and allocation remains a staple for a majority of cattle producers in the Fescue Belt, there is an opportunity for various grazing management techniques to be implemented with the main goal of extending the grazing season. One way that cattle producers in the Fescue Belt are able to extend the grazing season is through the use of stockpiling tall fescue. Alongside a typical rotational grazing management system, one pasture or grazing land is sacrificed, fertilized, and left to grow until the dormant season begins. Once the dormant season begins, cattle are then turned out on the “stockpiled” paddock to graze, ideally until the next grazing season begins.

There are several benefits associated with stockpiling tall fescue such as increased pasture persistence and animal performance and reduced hay-feeding days. Recommendations regarding stockpiled tall fescue should be updated to reflect current dry matter yield and quality values associated with stockpiled forage across multiple plant hardiness zones. In the end, it is important to understand how evaluation of forage management strategies like stockpiling tall fescue could potentially impact cattle operations, not only from an economic standpoint, but also from a plant and animal performance perspective.

CHAPTER TWO

LITERATURE REVIEW

Tall Fescue

According to the USDA in 2022, there were over 91 million head of cattle recorded in the United States (U.S.) (Matlock, 2022). Beef production in the U.S. is a diverse system that is divided into overlapping sectors that use various nutritional inputs to provide a finished product to consumers (Drouillard, 2018). The production sectors of the beef industry include cow-calf, stocker-backgrounder, and cattle finishing operations (USDA, ERS 2022). The Southeastern region of the U.S. is home to mainly cow-calf operations that use grazed or preserved forages as their primary nutritional resource. A large amount of pastureland in the eastern U.S. is covered by a cool-season perennial grass, tall fescue [*Schedonorus arundinaceus* (Schreb.) Dumort.]. Since tall fescue covers a vast amount of acreage, the region is commonly known as the Fescue Belt (Ferguson, 2021). The Fescue Belt is responsible for supporting approximately 40% of U.S. cow-calf operations, spanning over 35 million acres across 15 states (Ren et al., 2021). Tennessee, which is home to over 45,000 beef cattle operations accounting for over 16% of the state's agriculture cash receipts (Beef, n.d.), has predominately tall fescue pastures. Variables such as rainfall and temperature cause forage dry matter production to be highly variable from year to year, so the number of the grazing and hay feeding days may change each season (Boyer, 2020). By making efforts to extend the grazing season in fescue-based systems, hay feeding days and feed expenses can be decreased. Over the years, it has been determined that tall fescue is commonly known for enhanced agronomic features such as a longer growing period compared to other cool season perennial grasses and a more consistent yield across the grazing season (Roberts et al., 2009). On the other hand, there can be a decrease in animal performance due to the presence of the endophyte [*Neotyphodium coenophialum*] (M.H. Poore, 2000). Fortunately, since its discovery in 1942, researchers have focused on learning more about the negative effects the endophyte has on animal performance.

History

Tall fescue was discovered in eastern Kentucky in 1931 and was soon released as a cultivar in the U.S. in 1943 (Stuedemann & Hoveland, 1988). Given the growth distribution of the cool-season perennial grass, producers were able to capitalize on two growing seasons, one in the spring and one in the fall, year after year due to its strong persistence (Boyer, 2020). Unfortunately, cattle producers began to observe negative effects in cattle grazing tall fescue pastures. Initial symptoms noticed by producers include bovine fat necrosis and the summer slump, a general term for a collection of symptoms that present in summer months such as heat tolerance, increased salivation, elevated body temperature, and poor overall animal performance (Stuedemann and Hoveland, 1988). This collection of symptoms defines what is commonly known today as fescue toxicosis. Although fescue foot and fat necrosis were still concerns, fescue toxicosis became and is still the major concern when feeding in primarily tall fescue areas (Stuedemann and Hoveland 1988). Research focused on fescue toxicosis and symptoms associated with decreased cattle performance originally focused on outside factors that could possibly affect tall fescue, but in 1973, scientists isolated three different species of fungi that provided a foundation to continue grass toxicity analyses (Ferguson, 2021). Endophytic connections with other cool-season forages, like perennial ryegrass, led to the realization that an ergot alkaloid (*Epichloë coenophiala*) was responsible for symptoms associated with fescue toxicosis (Bacon, 1995). Since 1942, current research geared towards tall fescue is concentrated in mitigating the effects of tall fescue toxicosis in cattle herds.

General Characteristics and the Endophyte

Tall fescue is a perennial bunchgrass with shiny, rough-edged leaves and an average seasonal production yield of 2-4 tons DM/ac/yr. (Lacefield et al., 2003). It enters peak dry matter production from March to June with an additional period of lesser growth from September to December (Ball et al., 2015). Understanding the physiology behind endophyte-infected tall fescue aids in a better understanding of how to prevent fescue toxicity symptoms in cattle herds. Endophyte-infected tall fescue poses an issue in initial

identification since there is no visual marker to recognize endophyte presence from its outward appearance (Rogers & Locke, 1964). The endophyte and tall fescue exist in an internal symbiotic relationship that allows the plant to serve as a host for the fungus, and in return, alkaloids are produced that support plant persistence (Rogers and Locke 1964). Although the endophyte is present in many fescue-based pastures, forage quantity and quality measured in values such as dry matter yield, crude protein, neutral detergent fiber, and acid detergent fiber is comparable to other common cool-season perennial grasses (Pedersen, 1990).

Plant Hardiness Zones

The USDA Plant Hardiness Zone Map is the standard by which forage producers can determine which species are most likely to flourish in a given location. The map is based on the average annual minimum winter temperature, divided into 10-degree F zones and further divided into 5-degree F half-zones (USDA, 2020). Much of the Southeast US is located within plant hardiness zones 7 and 8. Average annual minimum winter temperatures within zones 7 and 8 range between 0° to 10° F and 10° to 20° F, respectively (USDA, 2020). The frost date, or when the temperature drops below 36° F, and the freeze date, or the date when the temperature drops below 32° F, differs between zones 7 and 8. The frost and freeze dates are October 21st and November 2nd, respectively for zone 7, and November 11th and November 18th, respectively, for zone 8 (Freeze/Frost Occurrence Data, n.d., U.S. Department of Commerce, n.d.). Lastly, rainfall is an important factor to consider when growing forages. Zones 7 and 8 rainfall averages between 53 to 54 inches of annual precipitation (U.S., 2019). Because rainfall and temperature have such a profound impact on forage dry matter production, it is important to consider these differences when formulating Extension recommendations.

Extending the Grazing Season

Each forage species has a specific growth distribution, or window of productive forage growth during the year. This coincides with the grazing season of that species. The main goal of managing the grazing season is to provide the greatest number of days that

cattle can graze without nutritional intervention. Programs such as “300 days of Grazing” at the University of Arkansas have been developed specifically to provide recommendations on how to meet the goal of extending the grazing season up to 300 days and reducing hay feeding days to 65 days by providing recommendations for different forage-based systems (Troxel, 2014). Recommendations based on different forage-based systems are highlighted in this program and producers may design a grazing management program intended to increase grazing days. Common Extension recommendations for extending the grazing season in TN include rotational grazing, cool-season annual forage utilization, and stockpiling tall fescue in Tennessee.

Management techniques like rotational grazing are common ways to increase efficiency by increasing animal gain and forage use efficiency (Bertelsen et al., 1993), and thus extend the days available for grazing. A study conducted by the University of Illinois looked into animal performance and forage characteristic differences in three grazing systems (Bertelsen, Faulkner et al. 1993). Three treatments, including continuous grazing, 6-paddock rotational grazing, and 11-paddock rotational grazing, were used as grazing pastures for 50 yearling crossbred heifers ranging from 888 +/- 111 lbs. in 1990, to 68 heifers ranging from 745 +/- 97 lbs. in 1991 across a 2-year study (Bertelsen, Faulkner et al. 1993). After collection of initial and final body weight, stocking rate, and gain per acre, it was determined that both rotational grazing scheme provided an improvement in forage use efficiency, animal gain, and stocking rate when compared to continuous grazing (Bertelsen, Faulkner et al. 1993).

There are also some other options to extend the grazing season into the winter like cool-season annual grass utilization (Bates, 1997). Cool season annual grasses can provide a short-term grazing period between seasons of perennial forage growth to increase quality and yield (Dillard et al., 2018). A study from Arkansas also corroborates that cool season annual grasses can provide a high-quality forage base from early fall into the spring (Beck et al., 2013). Specifically, research from 10 years of forage sampling of cool-season annual pastures consisting of wheat, rye, and annual ryegrass provided averages of 19.3 to 30.7% crude protein (CP), 39.6% to 57.2% neutral detergent fiber (NDF), 18.1% to 36% acid detergent fiber (ADF), and 67.1% to 78.8% dry matter

digestibility (DMD) and can provide anywhere from 100 to 120 days of additional grazing (Beck et al., 2013).

Stockpiling tall fescue is more commonly used alongside cool season annual grasses to extend the grazing season beyond a tall fescue stockpile. A study conducted by Bates et al. (2009) looked at the effects of overseeding cool season annuals with 3 different nitrogen application rates within a typical tall fescue stand. At the conclusion of this study, it was determined that a weak tall fescue stand may benefit from cool-season annual use, but there was no significant benefit from continuous use of cool season annuals on a long-term basis (Bates and Lane, 2009). Rather, stockpiling could achieve the goal of extended days of grazing without the added cost of establishing additional forage species.

Stockpiling – Method

There are several ways to preserve forage for later use including hay, baleage, or silage production. However, there is a method that eliminates the need for harvesting the forage using machinery, and instead creates a “standing hay crop.” This method is known as stockpiling and acts as a common way to extend the grazing season in the Fescue Belt. Stockpiling tall fescue consists of clipping and fertilizing tall fescue in late summer and letting it accumulate through the fall to then graze during winter months when forage growth is limited (Castillo et al., 2018). Tall fescue is used to stockpile due to its nutritive value retention and increase in growth compared to other cool-season perennial grasses (Kallenbach et al., 2003). There is also a general understanding that longer periods of accumulation will result in a larger quantity of stockpiled forage (Fribourg & Bell, 1984). A study done by Nave and others in 2016 determined that stockpiling can be a viable option for maintaining livestock (Nave et al., 2016). Nave reported an average forage mass of 1,995 lb. DM/ac over a 2-year period. In the end, the study reported no statistical difference between two different stockpiling initiation dates and nitrogen fertilization dates (Nave, Barbero et al. 2016).

Specific studies have been initiated to assess the quality and yield associated with stockpiling tall fescue. Fribourg and Bell (1984) evaluated the yield and nutritional

composition of stockpiled tall fescue for varying initiation dates. It was determined that earlier stockpiling initiation could result in an increase in dry matter accumulation, but a slight decrease in quality at its most mature point. Delayed initiation dates decrease accumulation amount, but overall higher quality was observed at the same termination date (Fribourg & Bell, 1984). It is thought to be due to a higher amount of green tissue as opposed to brown fescue tissue (M.H. Poore, 2000). Other studies support the idea of earlier initiation dates producing increased amounts of dry matter. Burns and Chamblee determined that DM yield could reach an annual average of 2,873 lb. DM/ac over a 3-year period when stockpiling occurred from June to mid-November in the fescue transition zone (Burns & Chamblee, 2000). Nutrient concentrations were measured among different initiation dates as well. Crude protein ranged from 12.6% - 13.2% across 5 initiation dates. (Burns & Chamblee, 2000). Neutral detergent and acid detergent fiber concentrations decreased from a range of 55.1% - 46.3% and 32.7% - 27.2%, respectively, among the 5 different initiation dates until mid-November. (Burns & Chamblee, 2000). In a similar study, Nave reported nutrient concentrations of 14.6% CP, 58.1% NDF, and 61.4% TDN (Nave et al., 2016). The overarching goal of studies like these are to provide information about the benefits associated with stockpiling tall fescue and how different initiation and termination dates can be utilized depending on location and available forage base.

From an economic standpoint, stockpiling tall fescue can be considered one of the more cost-effective methods to increase grazing days (Bates 1997). Equipment used to produce hay can increase the cost of forage as hay compared to grazing forage (Bates 1997). In Tennessee, the cattle producers feed hay for an average of 143 days each year (Griffith et al., 2019). Since hay is fed for over 4 months each year, studies have been conducted to assess the economic impact of a longer hay feeding period. One component of a demonstration conducted by Freeman and others in 2019 looked closer into the costs associated with traditional hay feeding compared to stockpiling tall fescue (Freeman et al., 2019). In the beginning, there is an increase in cost associated with stockpiling tall fescue due to fertilizer and allocating forage to account for the sacrificed area to

stockpile. As time goes on, there is a greater increase in cost associated with hay feeding due to the cost of energy and protein supplements alongside moving and transporting hay to feed, resulting in a difference of \$1.28, per head, per day (Freeman, Poore et al. 2019). Although this may seem small, using this number with the average herd size of 24 in Tennessee results in a \$30.72 difference per day that stockpiling tall fescue is utilized instead of hay feeding.

Adoption Practices

Although there are several benefits associated with stockpiling tall fescue, there is hesitancy among cattle producers to implement their practices. A study conducted by NC State Extension looked deeper into improving the adoption rate of stockpiling fescue as a grazing management practice in North Carolina (Freeman, Poore et al. 2019). A series of demonstrations were held across 13 counties of North Carolina to educate producers about stockpiling fescue, and an initial survey revealed that overall farm size, how the land is owned or managed, the region of the US producers inhabit, and their overall education level played a role in the decision to use stockpiling or other grazing management techniques (Freeman, Poore, et al. 2019). At the conclusion of the demonstrations, it was determined that 93% of farms that participated adopted grazing management and temporary fencing skills (Freeman, Poore et al. 2019). Similar studies in Tennessee could be useful in Tennessee continue to educate beef cattle producers using current Extension recommendations on grazing management strategies like rotational grazing, stockpiling tall fescue, and many more will not only increase forage and pasture persistence, but increase animal performance in the long term.

CHAPTER THREE

MATERIALS AND METHODS

Initial Setup and Experimental Design

A two-year stockpiling trial was conducted during the 2021-2023 stockpiling seasons at fourteen farms within 11 counties across Alabama and Tennessee (Figure 1). The experiment was a generalized complete block design with a 2 x 2 factorial of treatments. Treatments included plant hardiness zone, which included 2 levels, and stockpile period length, which included 5 levels. Year was the block. Location was the experimental unit ($n = 14$) and cage was the observational unit ($n = 3$ per location). Sampling sites were identified and split into two groups based on latitude (33.5186° N) which correlates with the dividing line between USDA Plant Hardiness Zones 7B and 8A (United States Department of Agriculture, 2020). Table 1 lists sampling sites within each zone. Treatments included plant hardiness zone and stockpiling length. Each farm met initial requirements of having one field or pasture comprised of tall fescue suitable for stockpiling.

In September 2021, three exclusion cages (4 ft x 4 ft) were constructed at each site to prevent any livestock intervention (Figure 2). At the time of cage setup, soil samples were taken and residual plant material within each exclusion cage was clipped to approximately 2 inches. Nitrogen fertilizer (34-0-0) was applied at a rate of 60 lb./ac N on individual plots. This rate is consistent with current Extension management recommendations for stockpiling tall fescue (Bates and Lane, 2009). In September 2022, new cages were set, and the clipping and fertilizer protocol was repeated.

Data Collection

After initial setup, on a monthly basis, a 1 ft² area within each cage was clipped to a 2-in stubble height. Sampling occurred monthly from October to February, representing the months that cattle would typically graze stockpiled tall fescue. Sampling dates were approximately 28 days apart and fell within the week of the 20th-30th of each month. Samples came from a new area within the plot each month to avoid overlap (Figure 2).

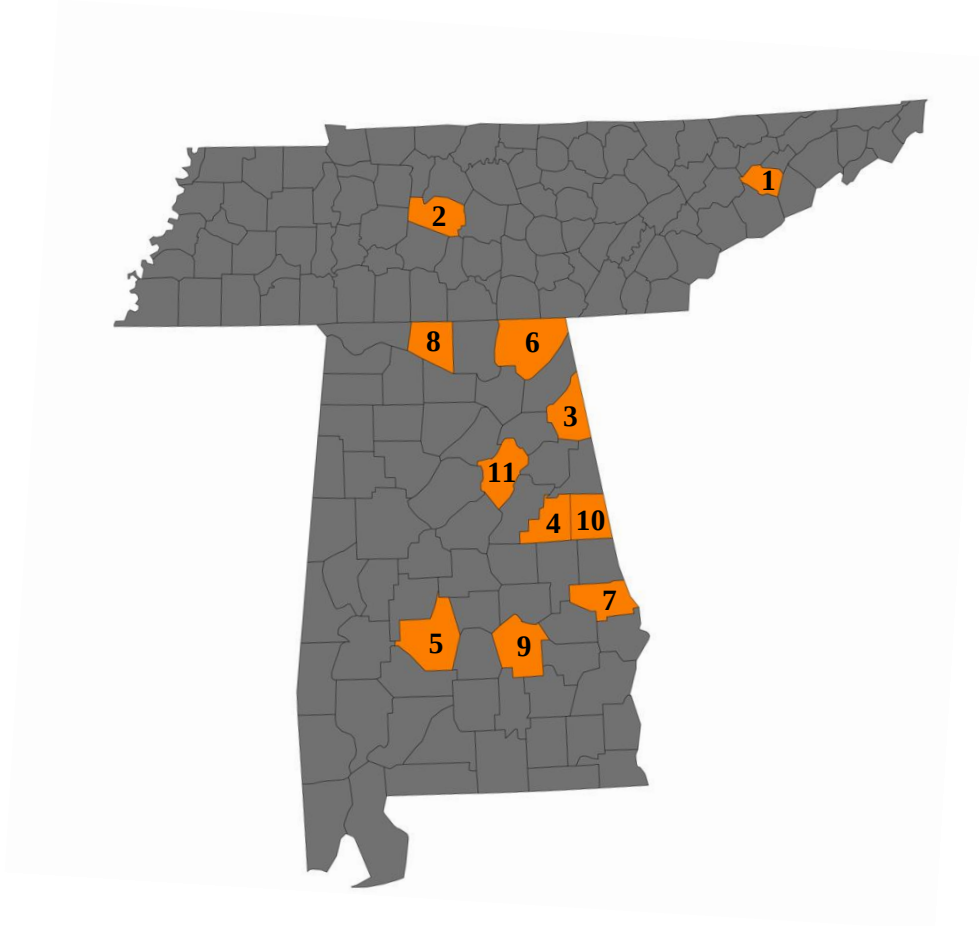


Figure 1. Sampling Site Map.

Fourteen sites were identified as sampling sites within 11 counties in Tennessee and Alabama. All sites met initial requirements of being a resident of Plant Hardiness Zones 7 and 8 and having one field or pasture suitable for stockpiling tall fescue. Participating counties include 1. Jefferson (n=1) and 2. Williamson (n=1) counties in Tennessee and 3. Cherokee (n=2) , 4. Clay (n=1), 5. Dallas (n=1), 6. Jackson (n=1), 7. Lee (n=1), 8. Limestone (n=3), 9. Montgomery (n=1), 10. Randolph (n=1), and 11. St. Clair (n=1) counties in Alabama.

Table 1. Sampling Site Identification

Location	State	Zone
Bramblett	AL	7
Bush's	TN	7
Gilbert Farms	AL	7
Mountain View	AL	7
MTREC	TN	7
Shelton	AL	7
St. Clair	AL	7
Thompson Farms	AL	7
Tigue Farms	AL	7
TVREC	AL	7
AUBTU	AL	8
Black Belt	AL	8
Hope Hull	AL	8
Upchurch	AL	8

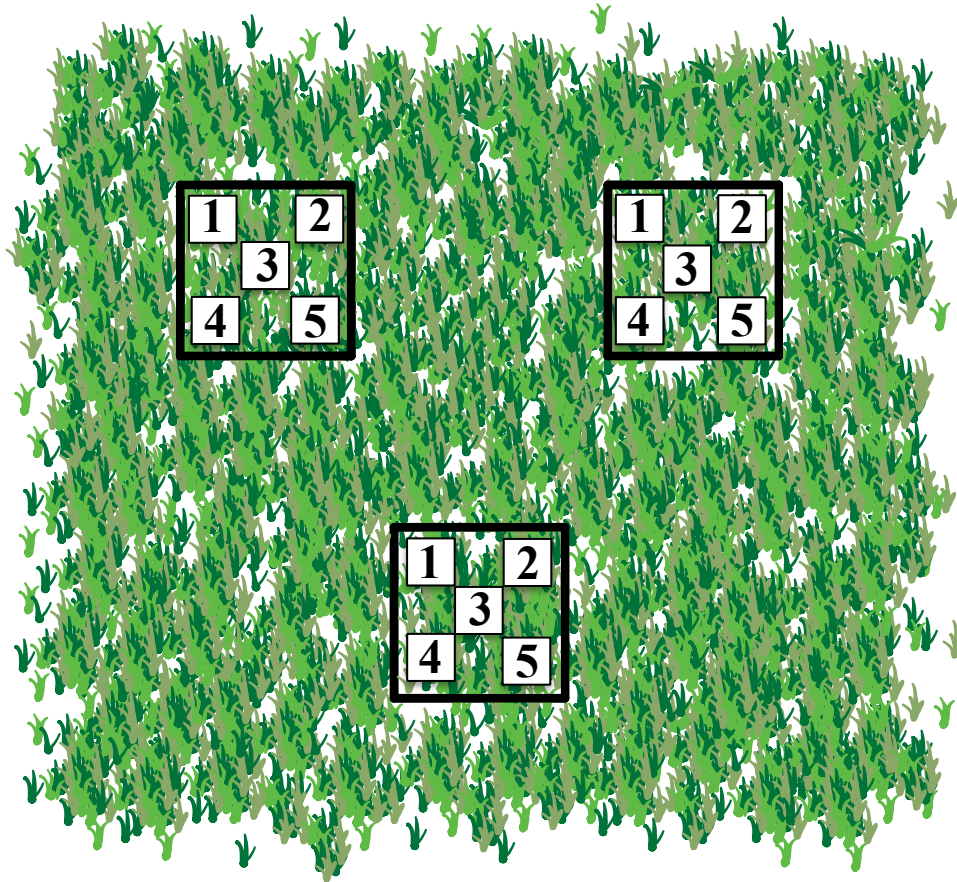


Figure 2. Exclusion Cage Sampling Procedure.

Samples were taken from a new area within each plot on a monthly basis from October to February. For example, samples in October were taken from box 1 within each cage at each location. Sampling occurred during months cattle would typically graze stockpiled tall fescue during the dormant period.

Immediately after collection, fresh weights were recorded and then transported within their respective states to the Auburn University Ruminant Nutrition Laboratory or the University of Tennessee Institute of Agriculture Forage Testing Laboratory. Finally, samples were dried, ground, weighed, and analyzed via near-infrared spectroscopy at the UTIA Forage Testing Lab.

NIRS Testing

Upon arrival, samples were placed into a forced-air oven to be dried at 131 degrees Fahrenheit for a minimum of 72 hours. Samples were weighed again to derive dry weight values and ground using a Wiley Mill (Thomas-Wiley Laboratory Mill Model 4, Arthur H. Thomas Co., Philadelphia, PA) passing through a 0.03-inch screen; followed by a cyclone sample mill (Foss Cyclotec, Foss North America, Eden Prairie, MN) ground to pass through a 0.03 inch screen (McIntosh et al., 2022). Samples were then placed back into a forced air oven at 131 degrees Fahrenheit to maintain consistent moisture for scanning in a near infrared spectrometer (NIRS) for less variability in all sample results. (McIntosh et al., 2022). The samples were scanned on a FOSS DS2500 NIR spectrometer using ISIScan Nova v. 8.0.6.2 (Foss North America, Eden Prairie, MN). Spectra were applied to the 2023 Grass Hay prediction calibration, provided, and licensed by the NIRS Forage and Feed Consortium (NIRSC, Berea, KY). Global and neighborhood statistical tests will be regulated and analyzed for accuracy across all predictions within the data set fitting the calibrations within the ($H < 3.0$) limit of fit and reported (Murray and Cowe, 2004). Units of measurement for nutritive analyses across all constituent data is reported at 100% dry matter (DM). The UTIA NIRS Forage and Feed Nutritional Analysis Laboratory provided complete validation statistics for NIRSC calibrations (McIntosh et al., 2022).

Statistical Analysis

Stockpiled forage mass and nutritive value components were analyzed using the PROC GLIMMIX procedure in SAS v 9.4 for a generalized complete block design (SAS Institute Inc. 2016). The independent variables were stockpile period length, zone, and

their interaction. Random variables were year, location nested within plant hardiness zone, and cage nested within location. Treatment means were separated using the LS MEANS procedure and were determined to be significant when $\alpha = 0.05$.

Economic Analysis

An economic analysis was completed to determine the number of grazing days supported and associated cost savings by stockpiled tall fescue in the current project. In a scenario where there is a typical herd size of 30 cattle in Tennessee weighing 1,250 lb. each that utilizes 20 acres of stockpiled tall fescue, we can assume that there will be an average of 3,356.3 lbs. per acre, or 67,126 lbs. total. With an efficiency rate of 60%, there will be 40,275.6 total lb. DM of stockpiled tall fescue available for grazing. Cattle consume 2.25% DM of their body weight daily, so for this scenario, a herd of 30 cattle would require 28 lb. DM per day per cow, or 840 lb. DM for the herd daily. Using the amount of available forage to consume, 40,275.6 lb. DM, and the total herd requirement of 840 lb. DM per day, there would be 47 days available for grazing using stockpiled tall fescue.

CHAPTER FOUR

RESULTS AND DISCUSSION

Forage Yield and Quality

Upon completion of statistical analysis, it was determined that as stockpile length increased forage dry matter yield increased ($P = <0.0001$). Dry matter yield ranged from 2,354 lbs. DM/ac to 4,391 lbs. DM/ac (Table 2). January, which represents 4 months' worth of stockpiled forage had the greatest DM yield, while October, or 1 month of stockpile, had the least. It is expected that forage growth will stop after the first frost and reach a plateau. In this study, forage dry matter yield did not strictly increase month-to-month. It is possible that variables such as plant tissue breakdown and winter weed presence caused the intermediate changes in forage dry matter yield, but botanical composition and green vs. brown plant tissue were not measured within the scope of this project. When fit with a logarithmic trendline, the resulting equation for lb. DM/ac is $y = 832.08\ln(x) + 2,442.2$. Observations in the current project agree with several studies that investigate the concept that forage will grow and accumulate new growth over time, regardless of initiation and termination date. Freeman and others determined that there was a 3-year average of 2,548 lb. DM/ac in stockpiled tall fescue pastures in North Carolina (Freeman et al., 2019). Plant hardiness zone did not have a significant effect on dry matter yield ($P = 0.2098$).

Stockpile length had a significant effect on crude protein (CP) concentration ($P = 0.0011$) such that CP decreased from 17.9% to no lower than 15.1% throughout the stockpiling period (Table 3). October had the highest concentration of CP and January had the lowest CP concentration during the stockpiling period. There was also a significant effect on stockpile length on total digestible nutrient (TDN) concentrations ($P = 0.0358$). TDN concentration varied during the stockpiling season from its highest of 70.1% in November, or month 2 of stockpile, to 68% in February. As stockpile enters later stages of maturity, it is understood that concentrations of nutrients such as CP and TDN will decrease as forage enters later phases of growth. Although there was no statistical difference among CP concentrations in a study by Nave et al. (2016),

Table 2. Change in Forage Mass Accumulation over the Stockpiling Period

Sampling Date	October	November	December	January	February	SEM
Unit ¹	----- (lb/ac) -----					
Forage Mass (lb/ac)	2,353.9 ^c	3,337.6 ^b	2,714.9 ^{bc}	4,391.5 ^a	3,396.4 ^b	1,280.7

¹ Within a row, means differ as indicated by superscripts ($P < 0.05$)

Table 3. Change in Forage Quality Component Concentrations over the Stockpiling Period

Unit ¹	Sampling Date					SEM
	October	November	December	January	February	
	----- % -----					
Crude Protein (CP)	17.9 ^a	16.6 ^{ab}	15.9 ^{bc}	15.1 ^c	15.9 ^{bc}	0.7
Total Digestible Nutrients (TDN)	68.9 ^{ab}	70.1 ^a	70.0 ^a	68.7 ^{ab}	68.0 ^b	0.9
Neutral Detergent Fiber (NDF)	54.0 ^{ab}	50.7 ^c	52.6 ^{bc}	55.3 ^{ab}	55.6 ^a	1.3
Acid Detergent Fiber (ADF)	28.5 ^b	27.7 ^b	27.6 ^b	29.1 ^{ab}	30.4 ^a	1.2
Ash	6.6 ^a	6.6 ^{ab}	6.1 ^{bc}	5.5 ^{cd}	5.1 ^d	0.8
Fat	2.5 ^a	2.6 ^a	2.6 ^a	2.5 ^a	2.6 ^a	0.1
Lignin	4.1 ^{ab}	4.2 ^{ab}	3.9 ^b	4.3 ^{ab}	6.0 ^a	1.5

¹ Within a row, means differ as indicated by superscripts ($P < 0.05$)

It was reported that CP concentrations fluctuated from as high as 16.7% to a minimum of 12.6% across a two-year sampling period. On the other hand, they observed an increase in TDN concentrations across a stockpiling period of September to November. It was speculated that there was a higher accumulated proportion of leaves to stems and dead material that could explain the increase in 2-year TDN averages from September to November (Nave et al., 2016). From the current study, it is interpreted that later stages of maturity will decrease overall CP and TDN concentrations after a 5-month stockpile period.

When considering a mature cow at 1,250 lbs. during peak lactation about 60 days after calving, the nutritional requirement is a diet with 11.2% CP and 61% TDN to maintain body condition and acceptable post-partum intervals (National Academies of Sciences & Medicine, 2016). The average stockpiled tall fescue CP and TDN concentrations in the current study could support cattle at their highest energy expenditure, even at its lowest quality of 15.1% CP and 68% TDN in February. Freeman and others' evaluation of stockpiled tall fescue compared to traditional hay feeding agrees with the observation that stockpiled tall fescue can provide greater nutrient density compared to traditional hay feeding. From October to March, there were higher concentrations of TDN and CP across the stockpiling period compared to a preserved hay crop (Freeman et al., 2019).

Stockpile length had a significant effect on acid detergent fiber concentrations (ADF) ($P = 0.0145$). ADF concentrations ranged from 27.6% in month 3 to 30.4% in month 5 from October to February (Table 3). Neutral detergent fiber (NDF) concentrations had a significant effect due to stockpiling length. NDF concentrations fluctuated from as low as 50.7% in month 2 of stockpile to the highest concentration of 55.6% in month 5 (Table 3). As forages reach later stages of maturity, it is assumed that fiber fractions of forages will increase over time. Research regarding NDF concentrations within forages has shown that cattle will consume more dry matter (DM) when fed forages with lower ADF and NDF fractions (Hoffman et al., 2001). Specifically, NDF influences intake, due to fiber bulk, of a specific forage when concentrations are greater than 60% (National Academies of Sciences & Medicine, 2016). Typically, the amount of

forage consumed decreases as NDF increases. An average NDF range of 50.7% to 55.6% during the stockpiling period demonstrates that overall dry matter intake should not be affected just on gut fill. ADF is a further fraction of the cell wall that is correlated to the digestibility of the forage (National Academies of Sciences & Medicine, 2016). A typical Extension recommendation states that high-producing, lactating cows should consume preserved forage with less than 30% ADF. (Forage Quality Interpretations – OSU, 2017) Typically, forages that remain at or below 30% ADF remain optimal without negative affecting digestibility. At its most mature point of 30.4% in February, these samples express the ability to not affect digestibility throughout the stockpiling period.

Lignin values were also significantly different from October to February ($P = 0.0070$). Lignin is an important value to consider when evaluating the nutrient concentration of forages due to its ability to limit other nutrient release in the rumen. Across the 2-year sampling period, lignin concentrations ranged from 4% to 6% from October to February. Samples across the stockpiling period remain similar to other evaluated tall fescue hay crops as well. Reeves analyzed fiber fractions across different forage crops during their specific growing season. It was determined that tall fescue hay lignin concentrations ranges from 6.3% to 9.1% during the fall growing season, or the typical stockpiling season (Reeves III, 1987). The current project found lower lignin concentrations from October to February, suggesting that there is greater nutrient digestibility for grazing animals during the stockpiling period.

Economic Analysis

The change in dry matter yield and nutrient concentrations over the stockpiling period have direct implications from an economic standpoint. Using the trendline equation for forage mass, $y = 832.08\ln(x) + 2,442.2$, the total grazing days available can be determined. Due to the increase in grazing days available, there is an associated decrease in cost when there is a decrease in supplemental feed or preserved forage needs. In Table 4, the total winter feed cost broken into hay feeding days and stockpiled tall fescue grazing days is presented. As additional months of stockpiled tall fescue are available, there is a decrease in the amount of hay feeding days each month alongside a

decrease in nutritional costs with more stockpiled forage availability. Stockpiled tall fescue could support additional grazing days under favorable weather conditions or increased acreage, further decreasing the need for hay or other preserved forage.

Assuming a 120-day hay feeding season, values associated with the cost of grazing stockpile versus feeding hay are presented. This would decrease the amount of hay feeding days to 74 days. To determine these values, hay feeding days were multiplied by \$2.54 and stockpiled tall fescue feeding days were multiplied by \$1.26, the average cost per cow per day to feed during the dormant season (Freeman et al., 2019). The cost to feed hay for 120 days is \$307.20. As stockpiled forage mass increases, grazing days increase, resulting in a decrease in total cow cost for the winter-feeding season. Data from the current study indicate that if grazing begins in December, the cost savings per cow would be \$64.93. If grazing were deferred until February, the cost savings per cow would be \$73.68. While the difference in cost savings between beginning grazing in December or February may not be tremendous, the cost savings in any amount of grazing versus hay feeding is substantial. This realized cost savings is great enough to justify the process of stockpiling tall fescue for winter-feeding season. Stockpiled tall fescue could support additional grazing days under favorable weather conditions or increased acreage, further decreasing the need for hay or other preserved forage.

Table 4. Economic Comparison of Stockpiled Tall Fescue versus Hay Feeding

		# of Days		Total Winter Feed Cost
Month	Yield	Stockpiled Tall Fescue	Hay Feeding	Cost per cow (\$)
No Stockpile	0	0	120	307.20
October	2,442.2	34	86	259.92
November	3,018.9	43	77	248.04
December	3,356.3	47	73	242.76
January	3,595.7	51	69	237.48
February	3,781.4	54	66	233.52

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Results from this study demonstrate that stockpiled tall fescue can be used to support cow herds during the dormant season, even if they were at their highest energy requirements. Due to the effect of time, dry matter accumulation increased over the stockpiling period alongside notable changes in quality from October to February. CP and TDN decreased in concentration while NDF and ADF increased over the stockpiling period. In the future, this information could be used as a decision tool when considering implementing stockpiling tall fescue as a forage management strategy in the Southeast. Producers will also be able to use this information to make improved nutritional management decisions during the winter-feeding period with additional goals of decreasing supplemental feed costs while increasing pasture persistence and animal performance.

Limitations

Though there are several direct benefits associated with collected data, there are also limiting factors associated with the current project. The initiation date of this project was later than a typical stockpiling season should begin. This may have resulted in dry matter yield and higher nutrient concentrations across the stockpiling period. Random effects such as year could have affected dry matter yield and nutrient concentrations as well. For example, drought conditions during the stockpiling period in year 2 of sampling decreased overall dry matter yield from October to February. Lastly, non-uniform sample collections among all 14 locations may have created inconsistencies; improved communication among collectors across the 14 locations could prevent these limitations.

Implications and Future Research

Future studies evaluating different aspects of stockpiling tall fescue will provide additional information and resources to further increase forage use and animal production

efficiency. For example, other research efforts that evaluate fertility rates, soil nutrients, and drought effects on stockpiled tall fescue will provide additional information on how tall fescue performs under optimal conditions compared to stressed conditions. Extension based research should also be considered to evaluate the adoption rate of stockpiled tall fescue, or why producers choose to implement stockpiling compared to other grazing strategies. In the end, this study provides information about stockpiling tall fescue and how it's application can increase profit margins, alleviate supplemental feed needs, and extend the grazing season.

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VITA

Malerie Fancher obtained her associate degree in animal science and veterinary medicine from Walters State Community College in Morristown, Tennessee, in December 2019. She went on to pursue and graduate with a bachelor's degree in animal science at the University of Tennessee in Knoxville in December 2021. She then continued her education to pursue a master's degree in animal science under the mentorship of Dr. Katie Mason with committee members Dr. Gary Bates and Dr. Kyle McLean. Her work focused primarily on the dry matter yield and nutritive quality associated with stockpiled tall fescue. In addition, she plans to work closely with producers in Tennessee to make better nutritional management decisions for grazing livestock.