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

Abstract

The objective of this study was to determine the nutritive value, yield, and economic benefits of stockpiling tall fescue (*Schedonorus arundinaceus* [Schreb.] Dumort.) to extend the grazing season. Samples were collected from 14 sampling sites across plant hardiness zones 7 and 8. Forage was clipped from exclusion cages monthly from October through February in years 2021 and 2022. Results did not differ between plant hardiness zones. Dry matter yield increased over the length of the stockpiling period, while nutritive value decreased. Results from this study indicate 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. Additionally, a decrease in hay-feeding days due to stockpiled forage availability can reduce winter feed cost per cow.

Keywords: nutritive value, stockpiled, tall fescue, yield.

Abbreviations: CP = crude protein; TDN = total digestible nutrients; N = nitrogen; NIRS = near infrared spectrometer; DM = dry matter; ADF = acid detergent fiber; NDF = neutral detergent fiber.

Introduction

The Southeastern region of the United States 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 et al., 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 and Alabama are situated within the Fescue Belt and are home to many cow-calf operations which rely on tall fescue to meet cow nutritional requirements. Although traditional hay preservation and allocation remains a staple for a majority of cattle producers in the Fescue Belt, there is an opportunity for extending the grazing season through various management methods. One way that cattle producers in the Fescue Belt are able to extend the grazing season is through the use of stockpiled 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 (Freeman et al., 2019). Previous recommendations highlight the benefits associated with stockpiled fescue. Specific studies have been initiated to assess the quality and yield associated with stockpiling tall fescue and show that dry matter alongside protein, neutral detergent fiber, acid detergent fiber, and total digestible nutrients increase with stockpiled fescue strategies (Burns and Chamblee, 2000; Fribourg and Bell, 1984; Nave et al. 2016). 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, specifically from samples taken from cattle farms, not just research stations, to encompass a wide variety of fescue systems. It is also important to understand the economic value of utilizing stockpiled tall fescue when compared with traditional hay feeding with current input prices.

This study was designed to determine nutritive value and dry matter yield of stockpiled tall fescue in plant hardiness zones 7 and 8, and to compare the cost of using stockpiled tall fescue to meet winter nutritional needs to the cost of traditional hay feeding. It was hypothesized that nutritive value would decline over the stockpile period, but would require little to no energy supplementation for mature cows.

Methods

Initial setup and experimental design

A two-year stockpiling trial was conducted during the 2021-2023 stockpiling seasons (September through February) 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.

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, consistent with Extension recommendations for stockpiling preparation, which ranges from 2 to 4 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.

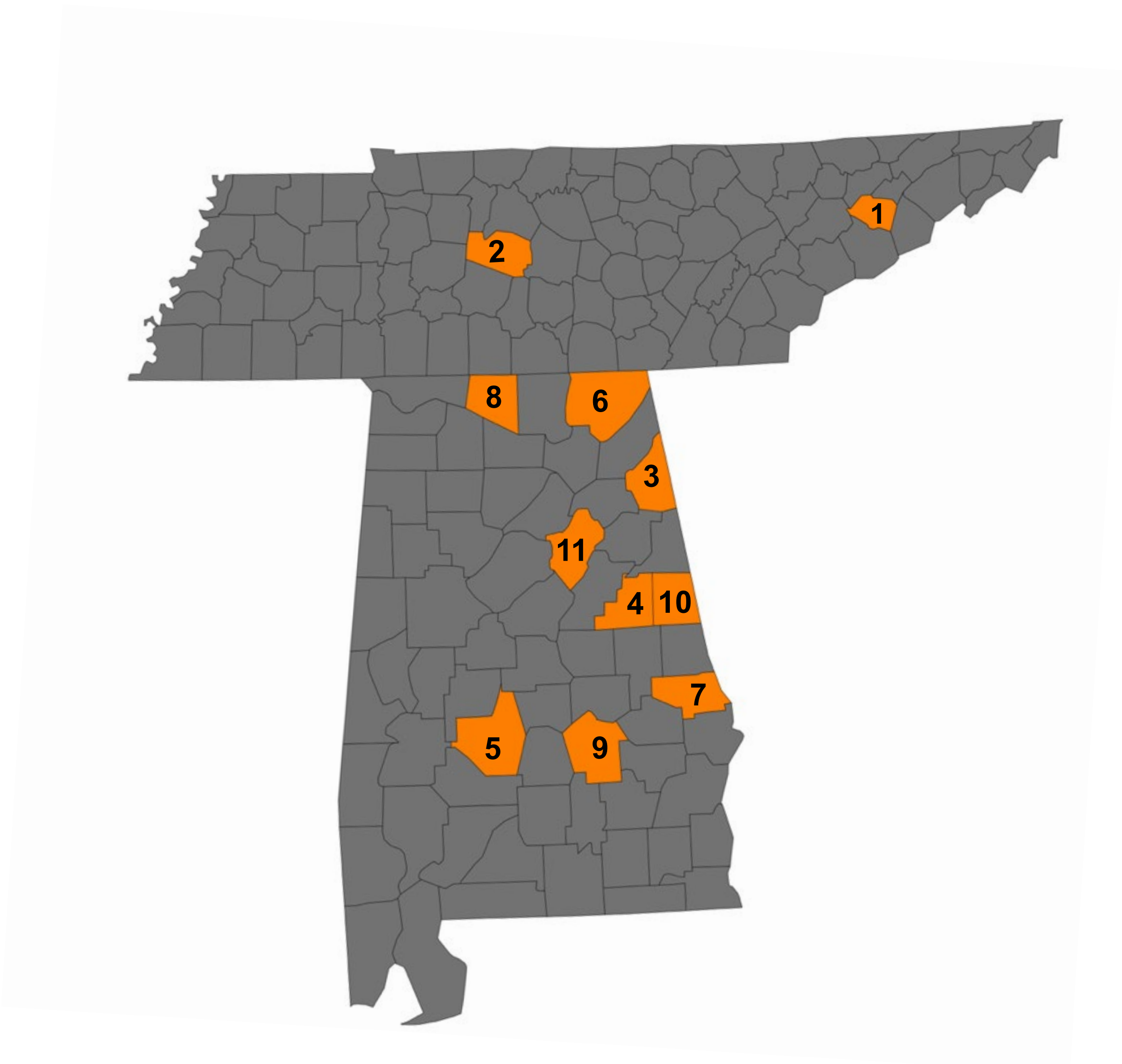

Figure 1. Sampling site map. Participating counties include 1. Jefferson (n=1) and 2. Williamson (n=1) counties in Tennessee and 3. Cherokee (n=2) , 4. Clay (n=1), 5. Dallas (n=1), 6. Jackson (n=1), 7. Lee (n=1), 8. Limestone (n=3), 9. Montgomery (n=1), 10. Randolph (n=1), and 11. St. Clair (n=1) counties in Alabama.

Table 1. Sampling site locations for stockpiled fescue in 2021 and 2022.

Location	State	County	Zone
Bramblett	AL	Cherokee	7
Bush's	TN	Jefferson	7
Gilbert Farms	AL	Limestone	7
Mountain View	AL	Cherokee	7
MTREC	TN	Williamson	7
Shelton	AL	Randolph	7
St. Clair	AL	St. Clair	7
Thompson Farms	AL	Limestone	7
Tigue Farms	AL	Jackson	7
TVREC	AL	Limestone	7
AUBTU	AL	Lee	8
Black Belt	AL	Dallas	8
Hope Hull	AL	Montgomery	8
Upchurch	AL	Clay	8

Data collection

After initial setup, on a monthly basis, a 1 ft^2 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 20^{th}-30^{th} of each month. Samples came from a new area within the plot each month to avoid overlap (Figure 2). 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.

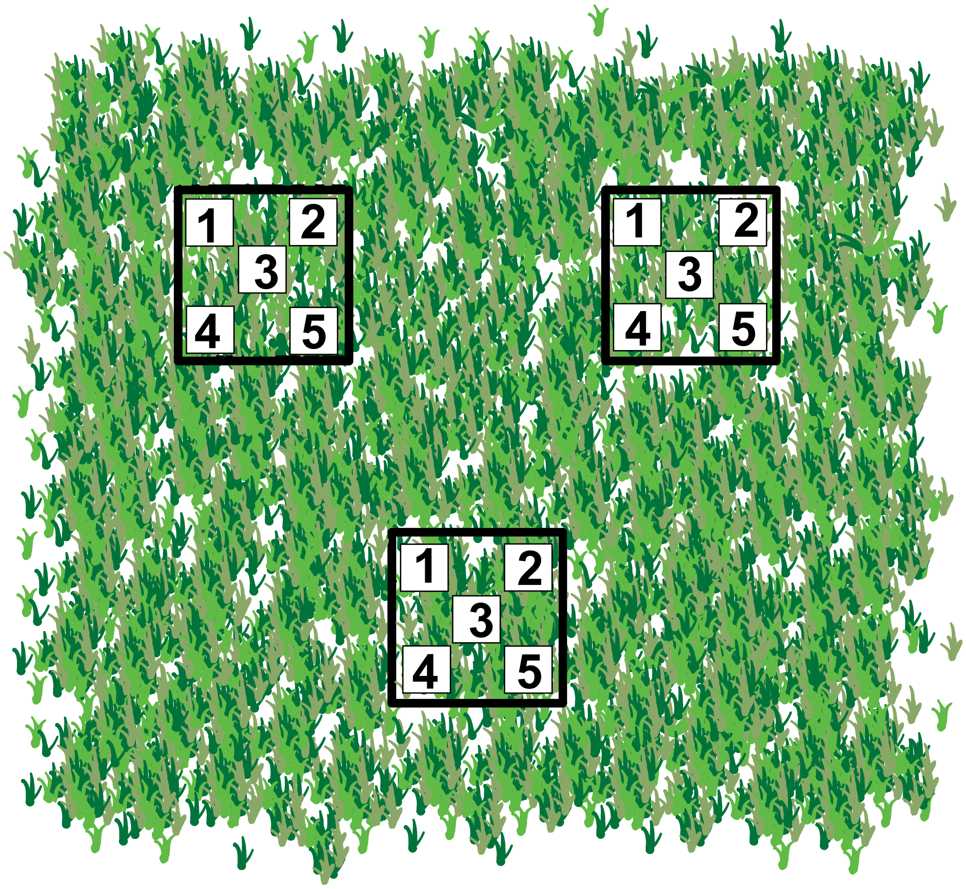

Figure 2. Exclusion cage sampling procedure. Samples were taken from a new area within each plot on a monthly basis from October to February. For example, samples in October were taken from box 1 within each cage at each location. Sampling occurred during months cattle would typically graze stockpiled tall fescue during the dormant period.

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 were 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 was 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 would be an average of 3,356.3 lbs. per acre, or 67,126 lbs. total. With an efficiency rate of 60%, there would 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.

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 (Figure 3). 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 (Figure 4). 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 (Figure 5). 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), 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.

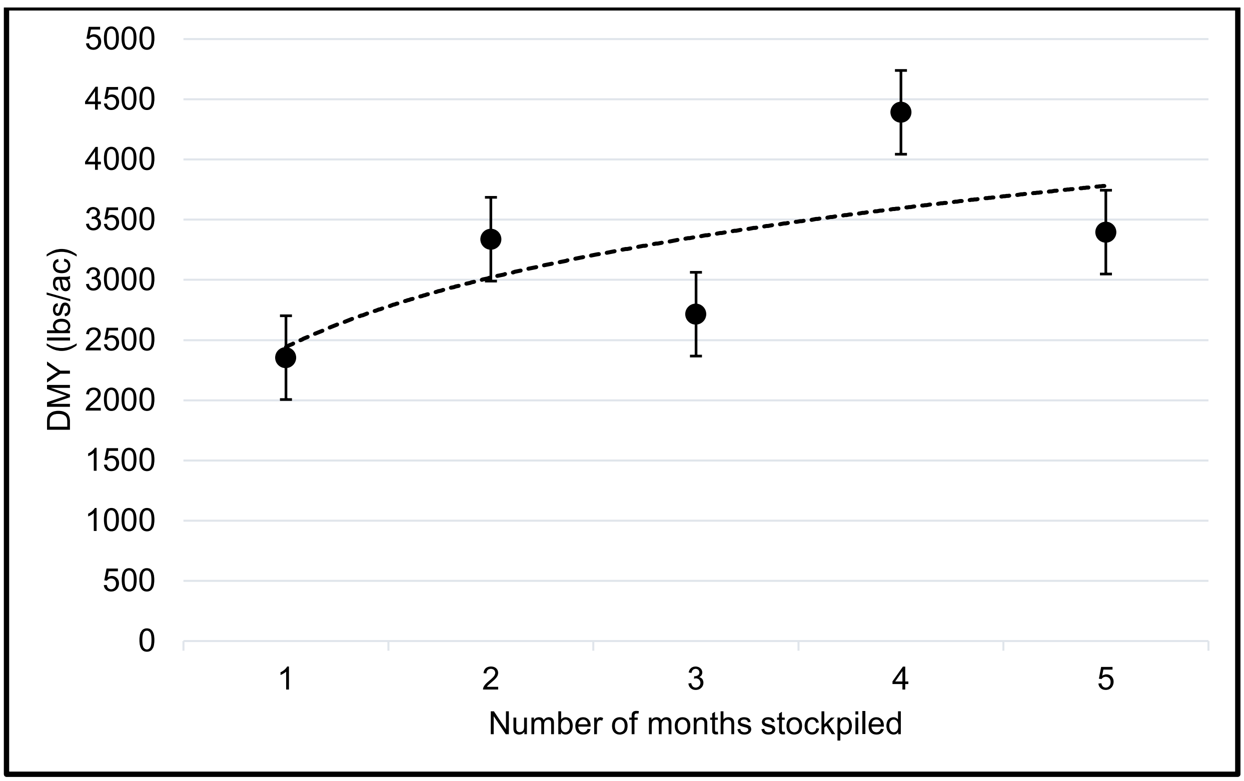

Figure 3. Average seasonal forage mass (lb. DM/acre) for stockpiled fescue in 2021 and 2022, where months stockpiled are October (1) through February (5). SEM = 1,280.7.

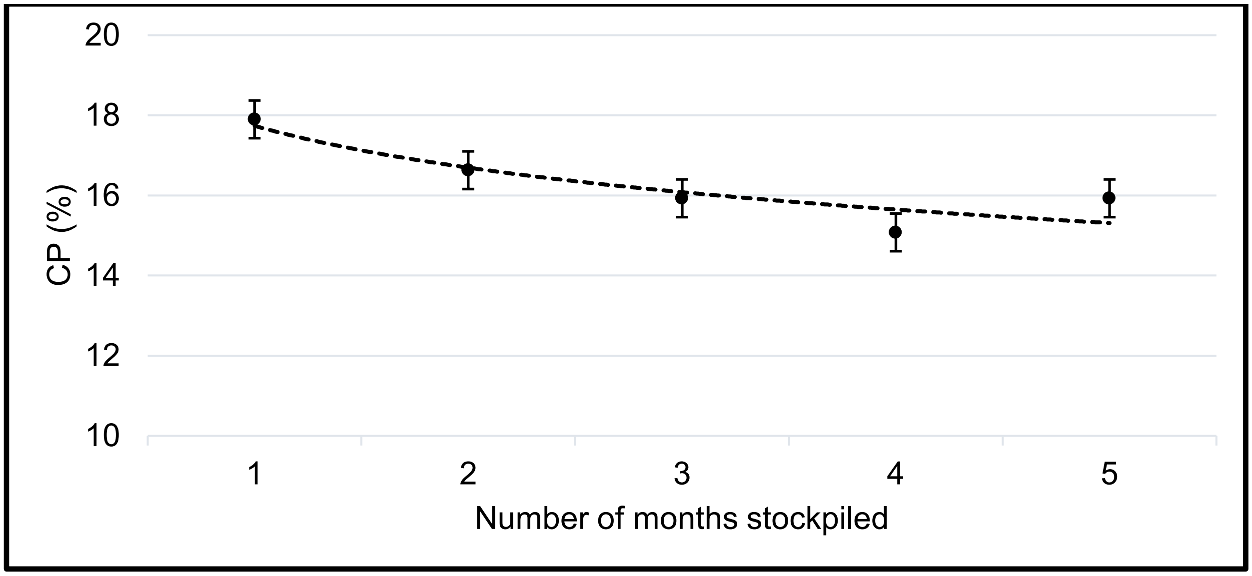

Figure 4. Average crude protein concentration (%) for stockpiled fescue in 2021 and 2022, where months stockpiled are October (1) through February (5). SEM = 0.7.

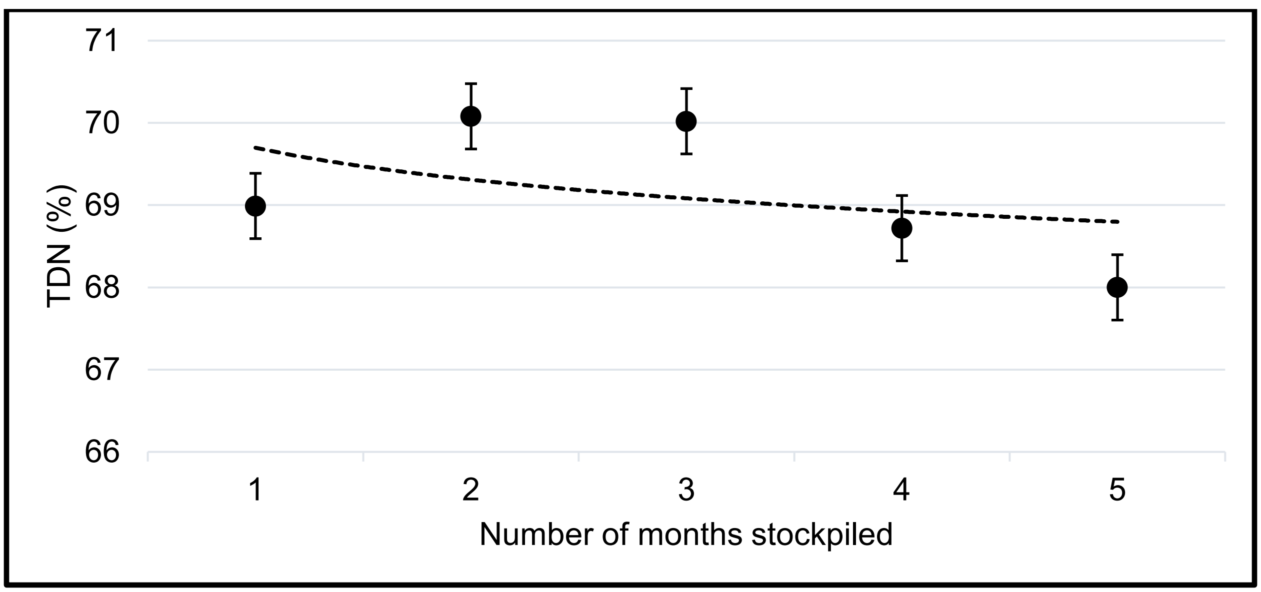

Figure 5. Average total digestible nutrient concentration (%) for stockpiled fescue in 2021 and 2022, where months stockpiled are October (1) through February (5). SEM = 0.9.

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, Engineering, and 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 (ADF) concentrations ($P = 0.0145$). ADF concentrations ranged from 27.6% in month 3 to 30.4% in month 5 from October to February (Figure 6). Neutral detergent fiber (NDF) concentrations had a significant effect due to stockpiling length. NDF concentrations fluctuated from a low of 50.7% in month 2 of stockpile to a high of 55.6% in month 5 (Figure 6).

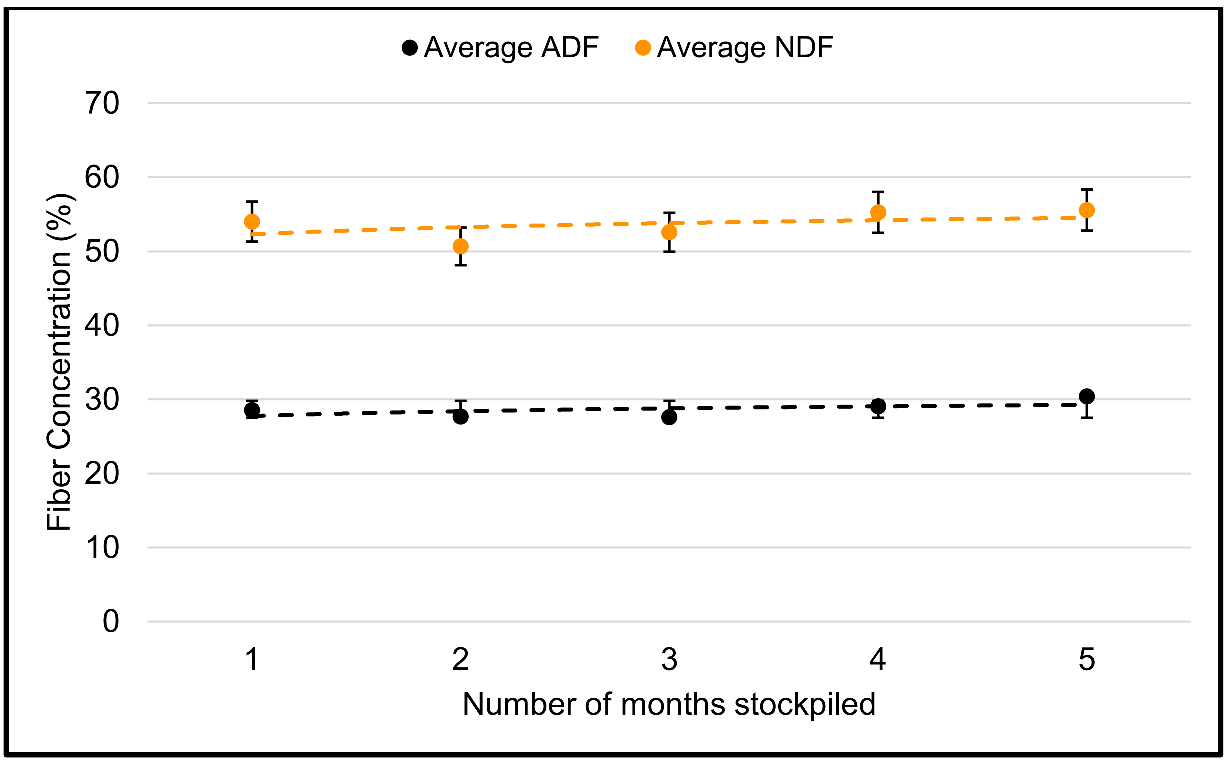

Figure 6. Average neutral detergent and acid detergent fiber concentrations (%) for stockpiled fescue in 2021 and 2022, where months stockpiled are October (1) through February (5). SEM for NDF = 1.3; SEM for ADF = 1.2.

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, Engineering, and 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, Engineering, and Medicine, 2016). A typical Extension recommendation states that high-producing, lactating cows should consume preserved forage with less than 30% ADF (Rocateli and Zhang, 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 changes 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 2, 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 2. Total winter feed cost per cow when hay feeding days are replaced by stockpiled tall fescue days.

		Stockpiled Tall Fescue	Hay Feeding	Total Winter Feed Cost
Month	Yield (lb DM/ac)	# of Days		Cost per cow ($)
No Stockpile	0	0	120	307.20
October	2,442.2	34	86	259.92
November	3018.9	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

Limitations

All collected data have direct benefits associated with stockpiling tall fescue, but there are also limiting factors associated with the project. The initiation date of this project was later than a typical stockpiling season and may have resulted in lower dry matter yields over the stockpiling season. Random effects like year and precipitation had the potential to affect dry matter yield and higher nutrient concentrations as well. For example, drought-like conditions in year 2 of sampling decreased overall combined dry matter yield averages from October to February. However, due to the variety in locations, especially with sampling sites located on producer farms and spread across two states, weather data was not collected for each site. Lastly, non-uniform sample collections, i.e. not always on the same date, across all locations could have created inconsistencies.

Conclusion

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. This research demonstrated an increase in dry matter yield 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, but overall nutritive value remained in acceptable ranges for mature cows. An economic analysis illustrated a cost savings associated with increased days of grazing stockpile. The acreage available for stockpiling and input costs related to feed and fertilizer should be considered when making the decision to stockpile fescue. Results from this study can be used to inform cattle producers about the expected yield and quality of stockpiled tall fescue and support the decision-making process for winter nutritional management.

Acknowledgement

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Conflict of Interest

The authors declare that there is no conflict of interest.

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