

# **Stockpiling Forage Grasses for Winter Grazing in West Tennessee**

A Research Paper Submitted to the Faculty of the  
University of Tennessee at Martin  
Fulfilling Requirements for the Degree of  
Master of Science in Agricultural Operations Management

Submitted by: Justin D. Pope  
May 2011

## Author's Limited-use Agreement

In presenting this completed paper in partial fulfillment of the requirements for an academic degree, I represent that it is an original Work and therefore assert the rights of an Author under Title 17 of the *United States Code* (copyright). I understand the University maintains one or more copies of the Work in its institutional archive as the permanent record of the Work's acceptance toward the degree, with the understanding that the University will maintain archival copies of the Work in such forms as best ensures its permanent preservation and continued public accessibility.

Notwithstanding the retention of copyright and all other rights to this Work, I recognize the University of Tennessee as the effective publisher of this paper and grant irrevocably to the University the following limited use of the Work in perpetuity:

a) representing the University, UTM University Archives may duplicate and distribute copies of the Work on the following terms, without recovering royalty payments or other considerations for the Author:

- i) the archival copy will be publicly accessible upon deposit and acceptance of the degree, and an electronic version of the Work will be posted for public accessibility and distribution on an institutional repository as an archival document, which may be downloaded by users without charge;
- ii) the UTM University Archives may duplicate copies of the Work as requested for the holdings of other academic libraries, so long as reproduction costs amount only to a sum required to recover actual duplication costs and shipping; however, the limited uses granted here do not transfer to other institutions holding copies of the work;

b) in the event that the Author or their heirs cannot be located after a documented good-faith effort is made by a user,

- i) the Author's lead graduate-committee professor shall have authority to grant permission for extensive quotation from the Work during the term of copyright, but not for publication of the Work;
- ii) in the professor's absence, University Archives shall have authority to grant permission for extensive quotation in its function as archival custodian for University theses and papers, but not for publication or performance of the work;
- iii) the University shall have authority to grant publication or performance permission to the Work as it stands in the deposit copy, provided the use is determined to be primarily scholarly or for demonstration, and non-commercial;

c) any duplication or use of the Work for financial gain of a user, except as stated here, is prohibited and duplication may be refused.

Author: \_\_\_\_\_

Date: \_\_\_\_\_

*Ant Pyle*  
4/26/11

## **ACKNOWLEDGEMENTS**

I would like to express my gratitude to all those who helped me during this time of study and research in the MSAOM program.

I would like to thank Dr. Richard Joost, for his guidance, planning, direction and data collection for my research. I would also like to thank Dr. Barbara Darroch for helping me analyze my data, compile this paper, and for providing motivation to finish my degree. To everyone who had a part in the completion of this project, I want to sincerely express my appreciation.

## ABSTRACT

With beef cattle producers looking for an alternative to traditional forage systems of feeding stored hay and silage in the winter months, stockpiling forages has become of interest. Stockpiling is the agricultural practice of maintaining pastureland throughout all seasons, including hot and dry periods of weather that greatly increase the percentage of dormancy in grasses. This is done by removing cattle from pasture in late summer and allowing the grass to grow for the cattle to graze in the late fall and winter. The species of grass in stockpiling is an important factor. Adequate rainfall and moisture in the late summer and autumn is also very important. An application of nitrogen fertilizer in the late summer can also increase yield potential of the grass.

A field study was initiated in August of 2006 to evaluate the effects of nitrogen fertilizer rate and different harvest dates on forage yield and percent moisture of stockpiled tall fescue (*Lolium arundinaceum*), orchard grass (*Dactylis glomerata*), and Bermudagrass (*Cynodon dactylon* (L)). In another trial, three varieties of tall fescue, Kentucky 31, Max-Q, And Triumph, were compared. For each of the species trials, a split-plot design with four replicates was used. Harvest date was the main plot and nitrogen rate was the sub-plot factor. Nitrogen fertilizer was applied at four rates (0, 45, 90, and 135 kg/ha) and the forage was harvested in December, January and February. The tall fescue variety study was arranged in a split-split plot design with four replicates. Three nitrogen fertilizer rates (45, 90, and 135 kg/ha) and two harvest dates (December and January) were used.

There was no significant ( $P < 0.05$ ) difference in percent moisture among harvest dates for Bermuda and orchard grass. However, for the fescue trial in 2006 and 2007, percent moisture was significantly ( $P < 0.05$ ) greater in January and February than in December. For the Bermudagrass experiment, there was no significant ( $P < 0.05$ ) difference in percent moisture among nitrogen fertilizer rates. In orchard grass and tall fescue, there were significant ( $P \leq 0.003$ ) linear contrasts for percent moisture of the forage in response to nitrogen fertilizer rate. In the tall fescue variety trial there was no significant difference in percent moisture among varieties. However, percent moisture of the forage was significantly ( $P < 0.05$ ) greater in January than in December. Fertilizer also had a significant linear ( $P < 0.05$ ) effect on percent moisture of the tall fescue forage in the variety trial.

Forage yield decreased ( $P < 0.05$ ) after January in the Bermudagrass and tall fescue trials. However, the yield of the orchard grass forage was significantly ( $P < 0.05$ ) greater in January than in December or February. There was a significant ( $P \leq 0.003$ ) linear contrast for yield in response to nitrogen fertilizer rate for all species. There was no significant ( $P < 0.05$ ) difference in yield among the different varieties in the fescue variety trial. In the fescue variety trial, forage yield was significantly ( $P < 0.05$ ) greater in December than in January. In addition, forage yield increased ( $P < 0.05$ ) as nitrogen fertilizer rate increased.

Stockpiling forages can be a useful tool for beef cattle producers. Depending on the amount of rainfall received and the species grass used an application of nitrogen fertilizer can increase forage yield. This study has shown that forages need to be

harvested by January to maximize yield and get maximum benefit from the stockpiled grass.

# TABLE OF CONTENTS

<b>Title</b>	<b>Page</b>
<b>Chapter I – Introduction</b> .....	1
Objectives .....	1
<b>Chapter II – Literature Review</b> .....	2
Economic Value .....	2
Fertilizer Application .....	4
Managing Stockpiled Forage .....	5
Tall Fescue .....	7
Orchard Grass .....	9
Bermudagrass .....	10
<b>Chapter III – Materials and Methods</b> .....	13
Plot Design .....	13
Experimental Setup .....	13
Data Collection .....	18
Statistical Analysis .....	19
<b>Chapter IV – Results and Discussion</b> .....	20
Percent Moisture.....	20
Yield.....	25
<b>Chapter V – Conclusion</b> .....	33
<b>Literature Cited</b> .....	34
<b>Appendix</b> .....	38

## LIST OF TABLES

<b>Table</b>	<b>Page</b>
Table 1. Percent Moisture response to harvest date and four rates of fertilizer application in 2006 and 2007 .....	22
Table 2. Effect of variety, harvest date, and nitrogen fertilizer rate on percent moisture.....	26
Table 3. Yield (kg/ha) response to harvest date and four rates of fertilizer application in 2006 and 2007.....	28

## LIST OF FIGURES

<b>Figure</b>	<b>Page</b>
Figure 1. Plot field plan for orchard grass research plots.....	14
Figure 2. Plot field plan for Bermudagrass research plots.....	15
Figure 3. Plot field plan for tall fescue research plots.....	16
Figure 4. Plot field plan for tall fescue variety plots. ....	17
Figure 5. Monthly precipitation totals recorded in Martin, TN during experiment. ....	21
Figure 6. Effect of harvest date on percent moisture of stockpiled Bermudagrass, tall fescue and orchard grass grown in Martin, TN in 2006 and 2007. ....	23
Figure 7. Effect of nitrogen fertilizer rate on percent moisture of stockpiled Bermudagrass, tall fescue, and orchard grass grown in Martin, TN in 2006 and 2007. ....	24
Figure 8. Effect of nitrogen fertilizer rate on % moisture of three tall fescue varieties grown in Martin, TN in 2006 and 2007.....	27
Figure 9. Effect of nitrogen fertilizer rate and harvest date on forage yield of grasses grown in Martin, TN in 2006 and 2007. ....	29
Figure 10. Effect of nitrogen fertilizer rate and harvest date of grasses grown in Martin, TN in 2006 and 2007. ....	31
Figure 11. Effect of nitrogen fertilizer rate on tall fescue grown in Martin, TN in 2006 and 2007. ....	32

## **CHAPTER I - Introduction**

Stockpiling is the agricultural practice of maintaining pastureland throughout all seasons, including stockpiling for winter grazing as well as for hot and dry periods of weather that greatly increase the percentage of dormancy in grasses. The innovative practice of stockpiling is more efficient than the traditional practice of conserving hay and silage for the winter months. The traditional method of conserving hay and silage has a much higher maintenance requirement than stockpiling. The long-established practice of conserving hay and silage requires a greater amount of physical labor, heavier use of associated machinery, and the inconvenience of maintaining storage and feeding facilities. Stockpiling forages for beef cattle production is an area that needs further research in northwest Tennessee.

### **Objectives**

The objectives of this study were to:

1. Determine the effect of nitrogen application rate (0, 40, 80, or 120 lbs/ac), on forage yield and percent moisture in Bermudagrass, tall fescue, and orchard grass.
2. Determine if timing of harvest has an effect on forage yield and percent moisture in Bermudagrass, tall fescue, and orchard grass.
3. Evaluate three cultivars of tall fescue (Ky 31, Triumph, or MaxQ) to determine the impact of forage yield and percent moisture.

## CHAPTER II - Literature Review

The system of stockpiling autumn sowed pastures can prove to be a valuable practice in forage production. By stockpiling tall fescue pasture for fall and winter grazing by beef cows, it is possible to provide a sizeable amount of high quality forage, while increasing economic returns (Allen et al. 1992). Stockpiling tall fescue (*Lolium arundinaceum*) works well, especially if there is adequate rain in the fall. Missouri studies have shown that grazing stockpiled grass can reduce wintering cost by 70% (Patrico 2002). Feeding hay is typically three times as expensive as grazing stockpiled grass (Liedner 2003). Year-round grazing practices that include grass-legume pastures and corn residue reduce the amount of hay required to feed cows and calves during long winter months compared with feeding hay in a dry lot.

### *Economic value*

The total cost of maintaining weaned calves by feeding harvested forage can be staggering, ranging from 18% to 24% of the total cost per calf. Grazing and feed costs make up approximately 40% of the total cost of a cow-calf operation. Corn, when used as a supplemental energy source, has the capability to of reducing wintering cost by up to 50%. Extended grazing can be more profitable than traditional forage systems for a cow-calf operation, but profitability varies depending on prices and weather. Winter grazing techniques can prove to be useful, even during inclement weather. Feed costs can be reduced by up to 70% even during periods of light snow accumulation (Patrico 2002). Stockpiled orchard grass can reduce feed costs 9.8% to 47.6% as compared to a daily ration of hay alone. In 2003, costs could be cut from 63 cents per cow per day

feeding hay to 11 cents per cow per day grazing stockpiled grass (Liedner 2003). In fact, stockpiled systems are estimated to cost about 43% less than any alternative feeding system that is based only on hay.

Extended grazing systems in the Midwestern states of the U.S. include grazing stocker cattle to maximize forage potential by utilizing excess forage growth. This practice reduces dependence on stored feeds, eliminating much of the outside costs of most winter feeding programs, including corn and silage (Janovick et al. 2004).

Stockpiling Bermudagrass (*Cynodon dactylon* (L)) forage for fall and winter grazing has the potential to greatly reduce production costs of cow-calf operations. To increase forage production nitrogen fertilizer should be applied to newly sowed pastures in autumn. The application of nitrogen fertilizer can decrease the number of acres required per animal. The costs of maintaining beef cows on stockpiled Bermuda grass pasture in 1995 was \$46 per cow compared to \$61 per cow to maintain cows for the same period using hay (Scarborough et al. 2004). Incorporating extended grazing of warm season grasses, along with other innovative approaches, can increase profitability for cow-calf operations in the southeastern U.S.. Forage capacity can easily be doubled with good management (Patrico 2002). In Missouri, the average cost of feeding a cow through the winter was \$100 dollars per cow in 2002. By using an extended grazing practice, the winter feeding period can be reduced from 120 days to 30 days or less, cutting costs by 70% with extended grazing (Patrico 2002). It is also possible that extended grazing practices may improve environmental quality, but more research is needed in that area (D'Souza et al. 1990).

### *Fertilizer Application*

An important management aspect of stockpiling is the use of appropriate fertilization to maximize forage yields. Bolasko (1977) researched the effects of nitrogen, phosphorus, and potassium fertilizer on tall fescue regrowth in late fall and winter, after three cuttings during the previous summer months. Bolasko (1977) found that nitrogen concentration in the winter forage had increased, and that plots of forage that received nitrogen had less senesced tissue than non-fertilized forage. Forage yields during summer and winter months, along with annual yields, increased by 2%-3% with the addition of nitrogen. Summer yields increased more from a nitrogen, potassium and a nitrogen, phosphorus, potassium treatment than from nitrogen alone or a nitrogen, phosphorus treatment. Nitrogen fertilization aided in maintaining viability of winter forage and decreased the amount of protein and calcium lost during December and January. Magnesium content was increased by nitrogen and decreased by potassium fertilizer. Taylor and Templeton (1976; as cited in Bolasko 1977) reviewed the effects of nitrogen fertilization on Kentucky bluegrass (*Poa pratensis*) regrowth during fall and winter. Overall, the use of nitrogen fertilization increased the yield of tall fescue and Kentucky bluegrass regrowth.

In contrast, Scarborough et al. (2004) noted that nitrogen fertilizer rate had little to no effect on dry matter yield or canopy height. Nitrogen fertilization improved only dry matter over 3-4 years, but was not cost effective without adequate rainfall. In this study, nitrogen treatments had no significant effect on crude protein content in stockpiled Bermuda-grass.

Numerous factors can affect the potential of nitrogen fertilized stockpiles. Rate of nitrogen application, initiation date, and harvesting date affect dry matter yield potential. One popular system involves applying nitrogen to tall fescue in the spring, making round bales of the first growth, and allowing regrowth to accumulate until late in the fall (Balasko 1977). Later, both the round bales and regrowth are available for general grazing. Generally, nitrogen treated plots had a higher percentage of green herbage in winter (Taylor and Templeton 1976). According to Gerrish (2005) an application of nitrogen at the beginning of the stockpiling process increases crude protein levels and may increase digestibility. The highest autumn-saved yields occurred when 112 kg of N/ha were applied at the last cutting. If winter grazing is desired, it is commonly suggested that 200 pounds of nitrogen per acre be applied during the early spring months. These higher nitrogen rates can produce 25% more dry matter than non-fertilized control plots (Scarborough et al. 2004).

### *Managing Stockpiled Forage*

Management of stockpiled grasses is a critical counterpart to fertilization habits. Liedner (2003) developed a management program to insure the greatest benefit from stockpiling. In this program, pastures are clipped to a height of 3-4 inches in mid-August and 50 to 70 pounds of nitrogen per acre are applied. It is necessary to keep the pasture free of all cattle until early winter. The use of strip grazing is also beneficial. Strip grazing allows cattle to graze a specific area of pasture for three to four days.

Scarborough et al. (2001) found that the most beneficial time period for initiation of cattle into a stockpiled pasture is early August. Scarborough maintained the

stockpiled forage by harvesting hay during the summer, over a nine week period, and as close to the initiation date of August 8-10 and September 4-6 as possible. Fertilizer was applied as necessary. Plots initiated in September produced only 30%-54% of the dry matter produced by plots initiated in August (Scarborough et al. 2001). Yields decreased over harvest dates. Forage samples taken after mid-December showed much lower nutritive value than any other samples.

In a comparable study, Coblenz et al. (1998), studied summer hay management, and stockpiled Bermudagrass beginning in mid-October. Chicken litter and nitrogen fertilizer were applied only in spring and late summer. The anticipated harvest dates were November 13, December 12, and January 9. Test plot #1 had two harvests of hay (12,600 lbs of dry matter per acre). After harvest, 65 cows and 25 calves were released to graze the test plot. The second test plot was continually grazed by 25 heifers and 1 bull beginning in April. In the first test plot forage availability was high, but plant height declined significantly over time. Plant height in the second test plot did not change, but forage availability increased after October 17. Overall no significant differences in total forage utilization were observed in the second test plot.

In research conducted by Balasko (1977), variable rates of nitrogen, phosphorus, and potassium were applied to tall fescue plots. Plots were harvested three times and 60 kg of nitrogen per hectare was applied after each harvest. Phosphorus and potassium were applied in spring and late summer. Overall, yields decreased by 10% from December to January. Total nonstructural carbohydrate was higher in December and January in plots fertilized with nitrogen than in plots without nitrogen. In vitro dry matter digestibility rates in January were an average of 2.8% less than rates measured

in December. Balasko (1977) concluded that fertilizer treatments and cutting management of forage accumulated from October 9 to December or January was superior in nutritional quality but had an inferior yield than that of previous months.

### *Tall Fescue*

There are multiple examples of successful systems of wintering beef cows and sheep on a minimum of barn-stored hay (Balasko 1977). Most of these programs have been thriving because of the implementation of tall fescue as the principal forage. According to Balasko (1977), fescue is as near to a perfect grass for North America as there is, due to its ability to grow in such a wide range of temperatures. Even though fescue is not a true cool season grass, it does perform well in cold weather. It was often referred to as “evergreen grass” in the late 1800’s (Balasko 1977). Since the late 1940’s, Kentucky 31, a variety of tall fescue, has been used as an effective stockpiled winter pasture for beef cows in much of the east central region of the United States. Kallenbach (2002) conducted research on tall fescue in Missouri and noted that winter grazing should work where tall fescue thrives, including central Iowa and Ohio and south to Tennessee and Kentucky (Patrico 2002). Acceptance of tall fescue for winter grazing has been relatively recent; previously fescue was not recommended for use as an extended grazing season in North Carolina and Tennessee (Balasko 1977).

Heifers grazing stockpiled tall fescue have almost twice the average daily gain with less than half the corn gluten feed supplement of heifers on dry lots (Leidner 2003). Cows that grazed tall fescue and red clover gained more weight from November through January, than cows that grazed orchard grass accompanied by red clover or

alfalfa. Stockpiled tall fescue can provide adequate nutrition for pregnant beef cows during fall and winter grazing. Cattle can gain a pound or more per day when grazing tall fescue (Price 1998). If tall fescue is used as hay, weight gain per day can be as much as one-quarter to one-half pound per day. Legumes generally increase the quality of stockpiled pastures, but cause the stockpiled pasture to deteriorate more rapidly (Gerrish 2005). Stockpiled tall fescue minimizes the need for supplemental harvested forages for winter. Suitability of stockpiling tall fescue for winter forage is highly dependent on the amount of rainfall that occurs during the month of August (Scarborough et al. 2004).

Cows grazing tall fescue and alfalfa or smooth brome grass and clover, and a corn crop residue were able to maintain a greater body weight and body condition score than cows confined in a dry lot (Hitz et al. 1998). In addition, these cows also required 627-1,069 kilograms of dry matter per cow less than cows kept in a dry lot. In vitro dry matter digestibility and total nonstructural carbohydrates with crude protein were also determined. The results showed that using stockpiled orchard grass during mid to late gestation and early lactation was a suitable alternative to using hay.

Tall fescue is also consistently more productive than Kentucky bluegrass. As the autumn season advances, less sugar is produced by Kentucky bluegrass than tall fescue. From December to March, both of these grasses have crude protein levels well above the levels needed to sustain a non-lactating beef brood cow (Taylor and Templeton 1976). Sward crude protein and sward sugar decreased from October onward in a study by Taylor and Templeton (1976). However, the amount of sward protein decreases sharply after the month of December. Nutritive value indices

increased during autumn and the high nutritive value was maintained throughout the winter.

Tall fescue is more suitable than orchard grass (*Dactylis glomerata*) for autumn sowing, primarily due to superior growth during autumn (Archer and Decker 1977). Orchard grass produces about 75% of the dry matter yield of tall fescue. Yield of Bermudagrass is dependent on precipitation, temperature, duration of stockpiling period, and the date and amount of nitrogen fertilization. Cost per animal is affected more by forage accumulation than by nitrogen rate, pasture, rental, or any other supplemental costs that can occur (Lalman et al. 2000).

### *Orchard Grass*

Grazing studies with steers and samples collected from under cages have shown that tall fescue and reed canary grass or tall fescue and ladino red clover provide an easily managed system for cow-calf operations (Allen et al. 1992). This method required minimum mechanical and labor requirements. The success of this operation was due to using one early spring cutting and late fall grazing of tall fescue and orchard grass.

Kartchner (1981) studied the effects of protein supplementation on intake and digestibility of cows grazing winter forage. The cattle received supplementation, but one group of cattle received no supplementation. Each group of cattle on supplements maintained or slightly gained weight. However, the non-supplemented cows began to lose weight during winter.

In another study conducted by Schoonmaker et al. (2003), cows were fed a limited amount of corn, stockpiled orchard grass, or orchard grass hay. The crude protein content of the stockpiled orchard grass was high enough to meet the requirements of pregnant or nursing cows. The total daily nutrient value and crude protein content of the stockpiled orchard grass exceeded the requirements of dry, mature cows.

### *Bermudagrass*

Unlike orchard grass, Bermudagrass is best used from the middle of October to the middle of December in northern Arkansas (Scarborough et al. 2004). This restriction is caused by the degradation of dry matter and neutral detergent fiber due to winter climate changes and the requirements of foraging cattle. Previously conducted experiments have shown coastal Bermudagrass to be highly responsive to nitrogen fertilization (Doss et al. 1966). Canopy height dramatically increased from the first to the second harvest date. However, the canopy declined rapidly before the third harvest. The grazing season of coastal Bermudagrass normally ends by late September or early October. Clipping studies involving coastal Bermudagrass indicate it produces very little usable forage after that time (Hart et al. 1970). For crude protein to exceed 18%, 500 lbs. of nitrogen per acre must be applied and the grass must be clipped once every three to four weeks.

When implementing a feeding program with Bermudagrass, it is important to evaluate the relationship between plant height and forage availability and the deterioration of forage quality that occurs in response to dormancy, weathering, and

grazing in the late fall and early winter months. It is also necessary to harvest Bermudagrass regularly (approximately every 5 weeks) in summer (Hart et al. 1970). Approximately 224 Kg of nitrogen per hectare should be applied around April 1, and after the first and last cuttings. Coastal Bermudagrass will not provide forage of adequate quality for late autumn or winter grazing. Therefore, grazing should be started before any frost.

Stockpiled Bermudagrass should be used during a limited time period usually during the fall, because nutritive value decreases after this time. The level of crude protein in Bermudagrass is also very sensitive and dependent upon the environment. As winter approaches, crude protein levels in Bermudagrass will begin to decline (Taliaferro et al. 1987). However, protein content can be increased by adding nitrogen or reducing clipping intervals. Even so, crude protein levels in stockpiled Bermuda grass are low and there may only be enough protein for nursing cows. The needs of dry pregnant beef cows are too high to subsist on only Bermudagrass hay throughout the winter months.

Several projects highlighting stockpiled forage combinations have been done across the United States, with many in Oklahoma and Arkansas (Lalman et al. 2000). In Nebraska, research projects examined the nature of stockpiling in choppy sands, sub-irrigated meadows and sand hill sites and found that grazing sub-irrigated meadows during May enhanced the profitability of all wintering systems (Adams et al. 1994). A grazing trial conducted in 1966 in Iowa studied fecal nitrogen to estimate dry matter digestibility of reed canary grass and tall fescue (Bryan et al. 1970). This study highlighted the time of year for fertilizer application instead of the rates of nitrogen. The

nutritive value index of reed canary grass and tall fescue was very high in June and remained high through late November.

Future research is needed to study the selection of forages and, in particular, the potential for the implementation of sub-irrigated meadows. Research is also needed to analyze the variability in stockpiled forage yield within different regions of the southern United States. A planned program of forage utilization is needed for 12 month forage systems in the hill land of the southern United States. Very little is known about the potential for stockpiling orchard grass or grass-legume combinations.

## CHAPTER III - Materials and Methods

### *Plot Design*

Field experiments were initiated in September 2005 and concluded in February 2007 on the University of Tennessee at Martin Teaching Farm. The experiments were conducted on established Bermudagrass, orchard grass, and tall fescue pastures. A split plot design with four blocks was used for each experiment. Harvest date was the main plot treatment and nitrogen fertilizer rate was the sub plot treatment (Figures 1, 2, and 3). Each plot was 0.077 ha (0.19 acre) in size (48 plots, 10 feet by 20 feet each).

In addition to the three experiments on different grass species, a tall fescue variety trial was conducted from September 2006 thru January 2007 on a plot that was established October 24, 2005. A split-split plot design was used for this trial with variety as the main plot treatment, nitrogen fertilizer rate as the sub-plot treatment and harvest date as the sub-sub-plot treatment (Figure 4). Each plot was 0.117 ha (0.29 acre) in size (72 plots total, 10 feet by 20 feet each; 12 sub plots, each 20 feet by 60 feet).

### *Experimental Set up*

The tall fescue, Bermudagrass, and orchard grass plots were mowed to height of 10.1 cm (4 inches) and fertilized on September 16, 2005 and September 28, 2006 with varying rates of dry nitrogen fertilizer. The nitrogen fertilizer was broadcast with no incorporation. Treatments evaluated in each experiment were nitrogen fertilizer rate (0, 40, 80, and 120 pounds of nitrogen per acre (0, 45, 90, 135 kg/ha)) and harvest date (December, January, and February).

Orchard Grass 2006

		February				January				December			
Rep IV		120	80	40	0	0	40	80	120	120	80	40	0
		January				December				February			
Rep III		0	80	40	120	80	120	0	40	0	40	80	120
		January				December				February			
Rep III		0	40	80	120	40	120	0	80	120	80	40	0
		February				January				December			
Rep I		120	80	0	40	80	40	0	120	0	80	120	40

N →

Figure 1. Plot field plan for orchard grass research plots.

Bermudagrass 2006

	December				January				February			
Rep IV	40	0	120	80	80	40	0	120	40	0	80	120
	February				January				December			
Rep III	80	0	120	40	80	40	0	120	120	0	40	80
	December				January				February			
Rep III	120	40	0	80	120	40	0	80	0	40	80	120
	January				February				December			
Rep I	80	0	120	40	40	0	80	120	120	0	40	80

N →

Figure 2. Plot field plan for Bermudagrass research plots.

Fescue 2006

N ↑

	February				January				December			
Rep IV	40	0	80	120	120	0	40	80	80	120	40	0
	January				February				December			
Rep III	0	80	40	120	80	40	0	120	80	0	40	120
	December				January				February			
Rep III	120	0	80	40	0	120	80	40	0	40	80	120
	December				January				February			
Rep I	80	120	40	0	80	0	40	120	80	40	0	120

Figure 3. Plot field plan for tall fescue research plots.

Fescue Variety trial 2007

N↑

	Triumph						Max Q						Kentucky 31					
Rep IV	D 80	J 80	J 40	D 40	J 120	D 120	D 120	J 120	J 40	D 40	D 80	J 80	D 40	J 40	D 80	J 80	J 120	D 120
	Triumph						Kentucky 31						Max Q					
Rep III	J 80	D 80	D 120	J 120	D 40	D 40	J 120	D 120	D 40	J 40	J 80	D 80	J 40	D 40	D 80	J 80	J 120	D 120
	Triumph						Kentucky 31						Max Q					
Rep III	D 40	J 40	J 80	D 80	D 120	J 120	J 120	D 120	J 80	D 80	J 40	D 40	D 40	J 40	D 120	J 120	D 80	J 80
	Triumph						Max Q						Kentucky 31					
Rep I	J 40	D 40	J 80	D 80	J 120	D 120	D 80	J 80	J 40	D 40	J 120	D 120	D 80	J 80	D 40	J 40	D 120	J 120

Figure 4. Plot field plan for tall fescue variety plots.

The tall fescue variety trial plots were mowed to a height of 10.1 cm (4 inches) and fertilized on September 28, 2006 with varying rates of dry nitrogen fertilizer. The nitrogen fertilizer was broadcast with no incorporation. Treatments evaluated in the experiment were variety (Kentucky 31, Triumph, and Max Q tall fescue grasses), nitrogen fertilizer rate (40, 80, and 120 pounds of nitrogen per acre (45, 90, 135 Kg/ha)) and harvest date (December and January).

#### *Data Collection*

Orchard grass, Bermudagrass and tall fescue plots were harvested on December 19, 2005; January 19, 2006; and February 24, 2006 for the 2006 experiment. For 2007, the same research plots were used and were harvested on December 15, 2006; January 19, 2007; and February 22, 2007. In 2007, the orchard grass and Bermudagrass plots were not harvested because there was not enough grass to harvest. The plots for the variety trial experiment were harvested on December 15, 2006 and January 19, 2007. An area of 2.55 square feet was harvested in the 2006 experiments. Each sample was weighed and wet weights were recorded. The samples were then dried and dry weights were recorded. A 3 foot by 20 foot (0.91 meter by 6.1 meter) section was harvested from the center of each plot in the 2007 experiments. The harvested plant material was weighed and recorded. A sub-sample was pulled from each plot; a wet weight was recorded, the samples were dried and dry weight was recorded. The percent moisture of the forage was calculated for each plot. All forage yields are recorded on a dry weight basis.

### *Statistical Analysis*

Data collected from all experiments were analyzed using the GLM procedure of SAS ( SAS Institute, Inc.). Data from each trial was analyzed separately. Tukey's Studentized Range Test was used to determine significant differences among treatment means. In addition, polynomial trend contrasts were used to look at the effect of N fertilizer rate on percent moisture and forage yield.

## CHAPTER IV - Results and Discussion

In 2007, the Bermudagrass and orchard grass plots were not harvested because there was no harvestable forage. There was ample rainfall during the experiment in 2007 (Figure 5.), but the Bermudagrass and orchard grass plots did not produce enough forage to harvest.

### *Percent Moisture*

Percent moisture of the forages was not expected to be affected by nitrogen fertilizer rates or harvest date. As expected, there were no significant ( $P < 0.05$ ) differences in percent moisture among harvest dates for Bermuda and Orchard grass (Table 1, Figure 6). However, there was a significant ( $P < 0.05$ ) difference in percent moisture among harvest dates for the fescue trial in 2006 and 2007. Differences in the amount of rainfall and snow could be the reason for the observed differences in percent moisture (Figure 5). For all species trials, there was no significant ( $P < 0.05$ ) harvest date by fertilizer rate interactions.

For the Bermudagrass experiment, there were no significant ( $P < 0.05$ ) differences in percent moisture among nitrogen fertilizer rates (Table 1). For both tall fescue (in 2006 and 2007) and orchard grass, however, there were significant ( $P < 0.05$ ) differences in percent moisture among fertilizer rates. In both species, there was a significant ( $P \leq 0.003$ ) linear contrast for percent moisture of the forage in response to nitrogen fertilizer rate (Table 1, Figure 7). The higher amount of nitrogen applied, the greater was the percent moisture in the harvested forage.

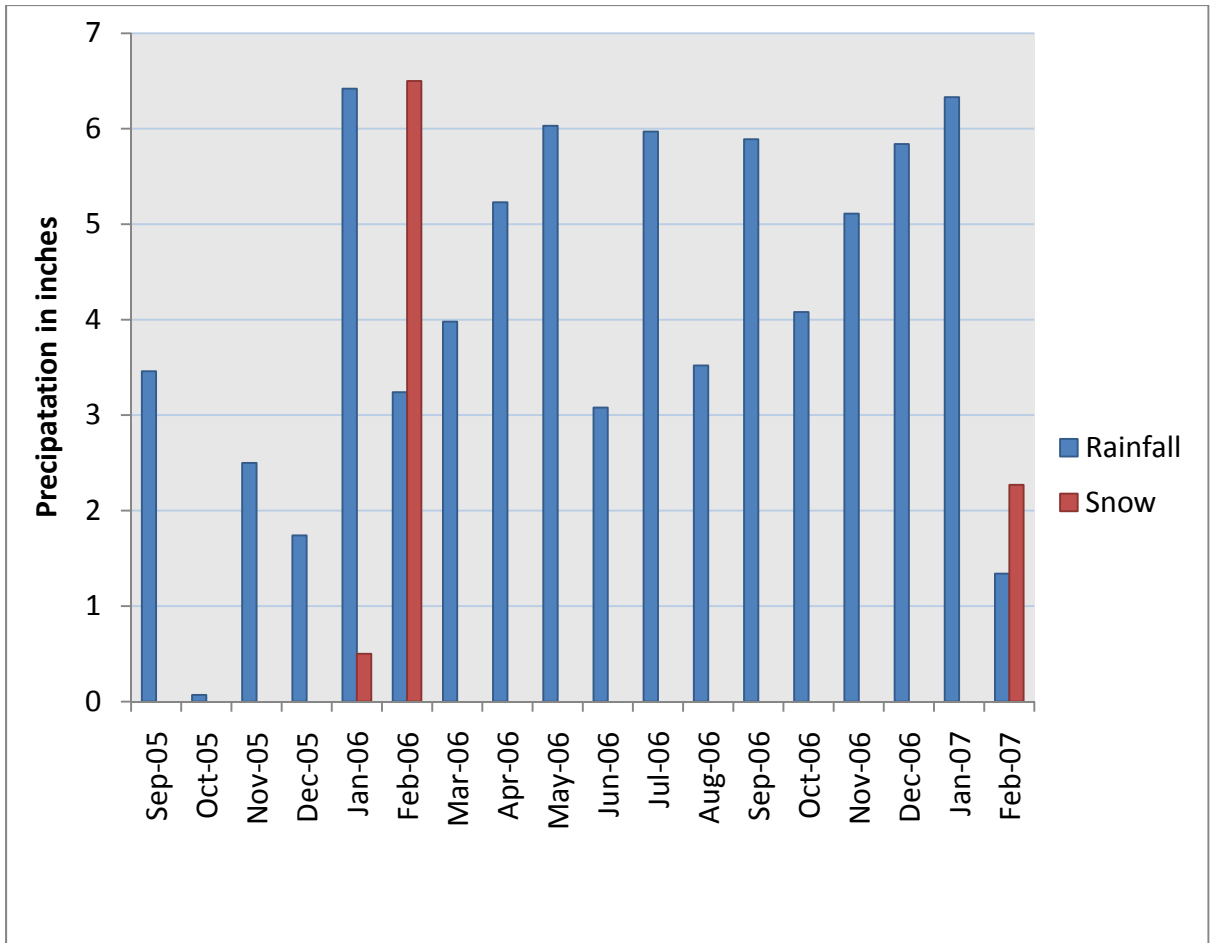


Figure 5. Monthly precipitation totals recorded in Martin, TN during experiment.

Table 1. Percent Moisture response to harvest date and four rates of fertilizer application in 2006 and 2007

	Moisture Content			
	Bermudagrass '06	Orchard Grass'06	Tall Fescue '06	Tall Fescue '07
<b>Harvest Date</b>	% Moisture			
Dec.	23.3a†	50.3a	43.5b	46.1b
Jan.	25.5a	52.1a	57.6a	59.6a
Feb.	21.1a	53.1a	54.8a	54.9a
<b>Nitrogen Fertilizer Rate</b>				
0	23.7a	48.2b	47.5c	49.0b
40	23.2a	51.5ab	49.7bc	53.0ab
80	22.5a	53.6a	55.1ab	55.2a
120	23.7a	53.9a	55.4a	57.1a
<b>Contrasts‡</b>	P value			
Linear	0.874	<.0001	0.0001	0.003
Quadratic	0.460	0.098	0.525	0.552
Cubic	0.662	0.8809	0.215	0.870

† Within a column and within a treatment effect, means with the same letter are not significantly different by Tukey's Studentized Range Test ( $P \leq 0.05$ ). n=16 for harvest date means and n=12 for nitrogen rate means.

‡ Linear, quadratic, and cubic contrasts were calculated to determine trends in yield response to nitrogen fertilizer rate.

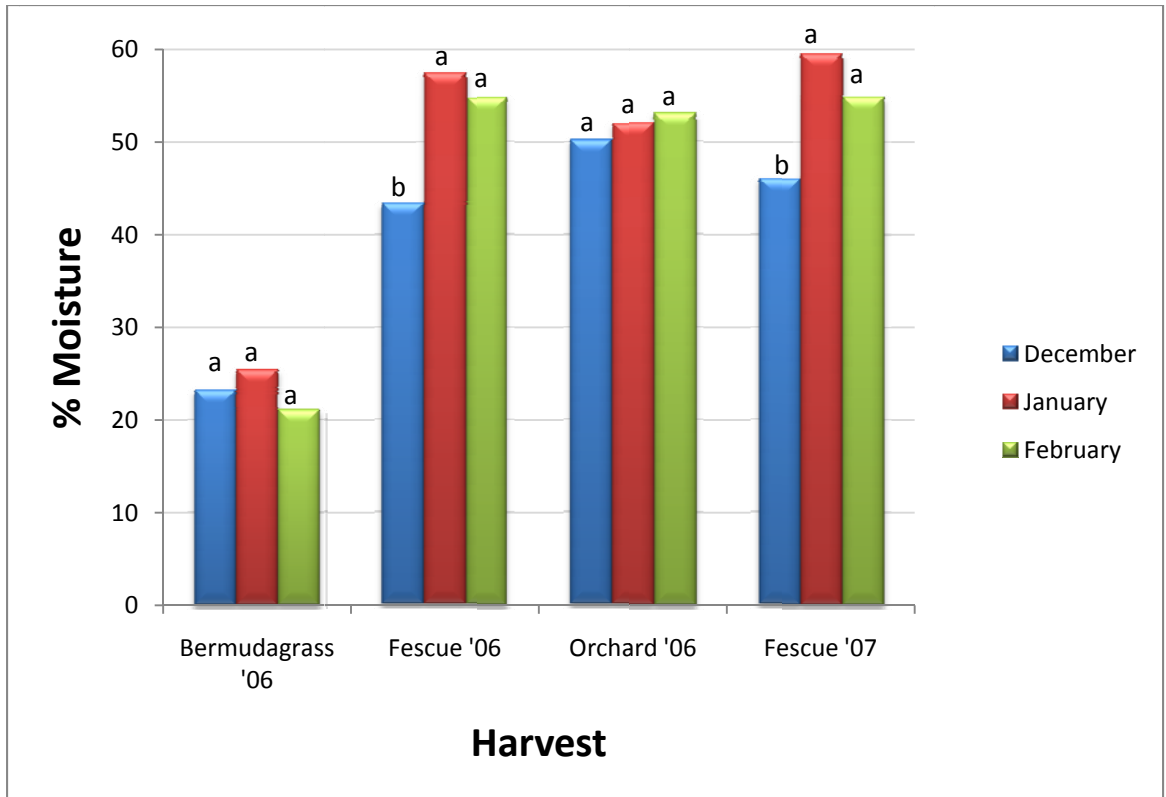


Figure 6. Effect of harvest date on percent moisture of stockpiled Bermudagrass, tall fescue and orchard grass grown in Martin, TN in 2006 and 2007. Within each grass species, means with the same letter are not significantly different by Tukey's Studentized Range Test ( $P \leq 0.05$ ).

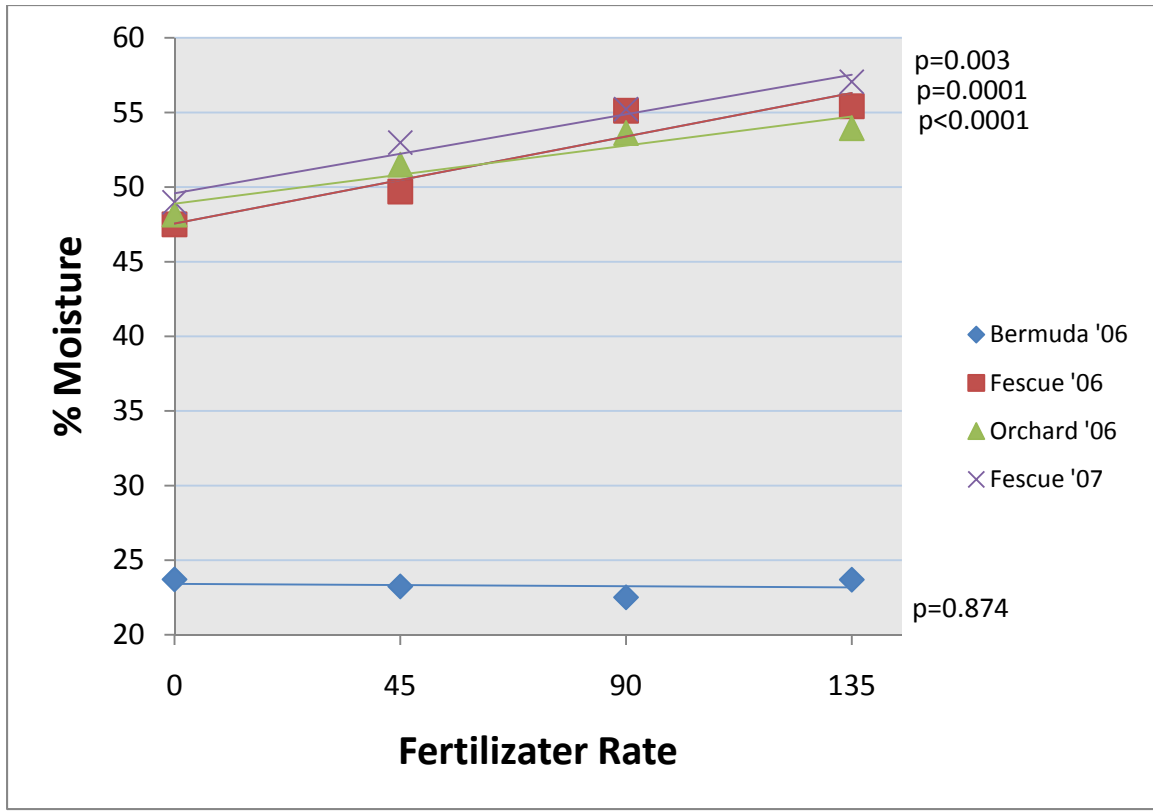


Figure 7. Effect of nitrogen fertilizer rate on percent moisture of stockpiled Bermudagrass, tall fescue, and orchard grass grown in Martin, TN in 2006 and 2007. P values indicate significance of linear contrasts.

In the tall fescue variety trial, there was no significant ( $P < 0.05$ ) difference in percent moisture among varieties (Table 2). However, percent moisture of the tall fescue forage was significantly ( $P < 0.05$ ) greater in January (63% moisture) than in December (54% moisture). Again, differences in rainfall or snowfall between December and January may have accounted for these observed differences (Figure 5). Fertilizer rate also had a significant ( $P < 0.05$ ) effect on percent moisture of the tall fescue forage in the variety trial. Higher nitrogen rates led to higher moisture contents (Table 2, Figure 8). Perhaps the higher yields associated with the higher rates of applied nitrogen led to the observed increase in percent moisture. No significant ( $P < 0.05$ ) interactions were observed for percent moisture in the fescue variety trial.

### *Yield*

Yield of the forages was expected to decrease later in the winter. The results did show significant ( $P < 0.05$ ) difference in yield among harvest dates for all three grass species (Table 3). As expected, forage yield of Bermudagrass and tall fescue decreased after the January harvest date (Table 3, Figure 9). However, forage yield of the orchard grass was significantly ( $P < 0.05$ ) greater in January (2,794.5 kg/ha) than in December (2,091.7 kg/ha). Overall, a producer would benefit most if the stock piled forages are harvested before February.

It was also expected that the yield of the forages would increase as nitrogen fertilizer rates increased. Although the ANOVA showed no significant ( $P < 0.05$ ) yield differences for orchard grass and tall fescue (2007) there were significant ( $P < 0.05$ ) linear contrasts for yield in response to the nitrogen fertilizer rates for all species trials

Table 2. Effect of variety, harvest date, and nitrogen fertilizer rate on percent moisture

	<b>Moisture Content</b>	<b>Forage Yield</b>
<b>Variety</b>	<b>%</b>	<b>Kg ha<sup>-1</sup></b>
Triumph	60.4a†	566.5a†
Max Q	59.8a	629.3a
KY 31	55.1a	663.1a
<b>Harvest Date</b>		
Dec.	53.6b	729.7a
Jan.	63.3a	509.6b
<b>Nitrogen Fertilizer Rate</b>		
40	56.8b	586.1b
80	57.7ab	587.6b
120	60.8a	685.3a
<b>Contrasts‡</b>	<b>P value</b>	
Linear	0.016	0.024
Quadratic	0.416	0.185

† Within a column and within a treatment effect, means with the same letter are not significantly different by Tukey's Studentized Range Test ( $P \leq 0.05$ ).  $n=16$  for harvest date means and  $n=12$  for nitrogen rate means.

‡ Linear and quadratic contrasts were calculated to determine trends in yield response to nitrogen fertilizer rate.

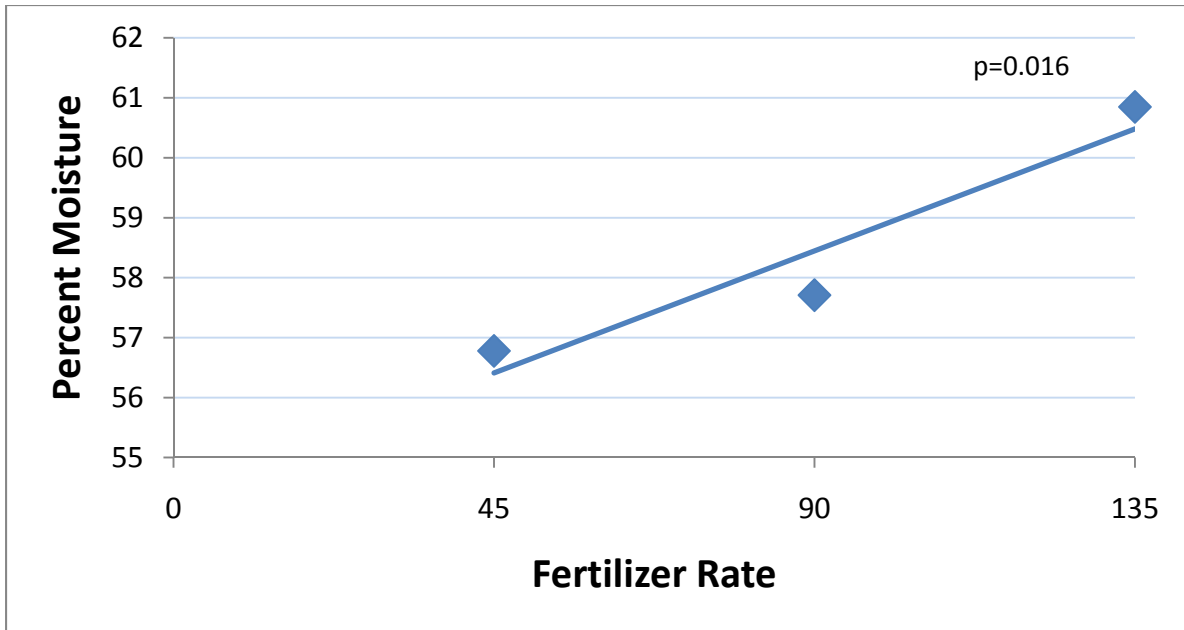


Figure 8. Effect of nitrogen fertilizer rate on % moisture of three tall fescue varieties grown in Martin, TN in 2006 and 2007. P value indicates significance of linear contrasts.

Table 3. Yield (kg/ha) response to harvest date and four rates of fertilizer application in 2006 and 2007

	Forage Yield			
	Bermudagrass '06	Orchard Grass'06	Tall Fescue '06	Tall Fescue '07
<b>Harvest Date</b>	<b>Kg ha<sup>-1</sup></b>			
Dec.	4882a†	2092b	5769a	1020a
Jan.	4646a	2795a	5680a	871a
Feb.	3436b	2729ab	3494b	365b
<b>Nitrogen Fertilizer Rate</b>				
0	3948b	2293a	4163c	710a
40	4184ab	2500a	4612bc	712a
80	4351ab	2662a	5276ab	779a
120	4802a	2698a	5874a	807a
<b>Contrasts‡</b>	<b>P value</b>			
Linear	0.021	0.044	0.001	0.041
Quadratic	0.105	0.563	0.837	0.722
Cubic	0.525	0.903	0.861	0.529

† Within a column and within a treatment effect, means with the same letter are not significantly different by Tukey's Studentized Range Test ( $P \leq 0.05$ ).  $n=16$  for harvest date means and  $n=12$  for nitrogen rate means.

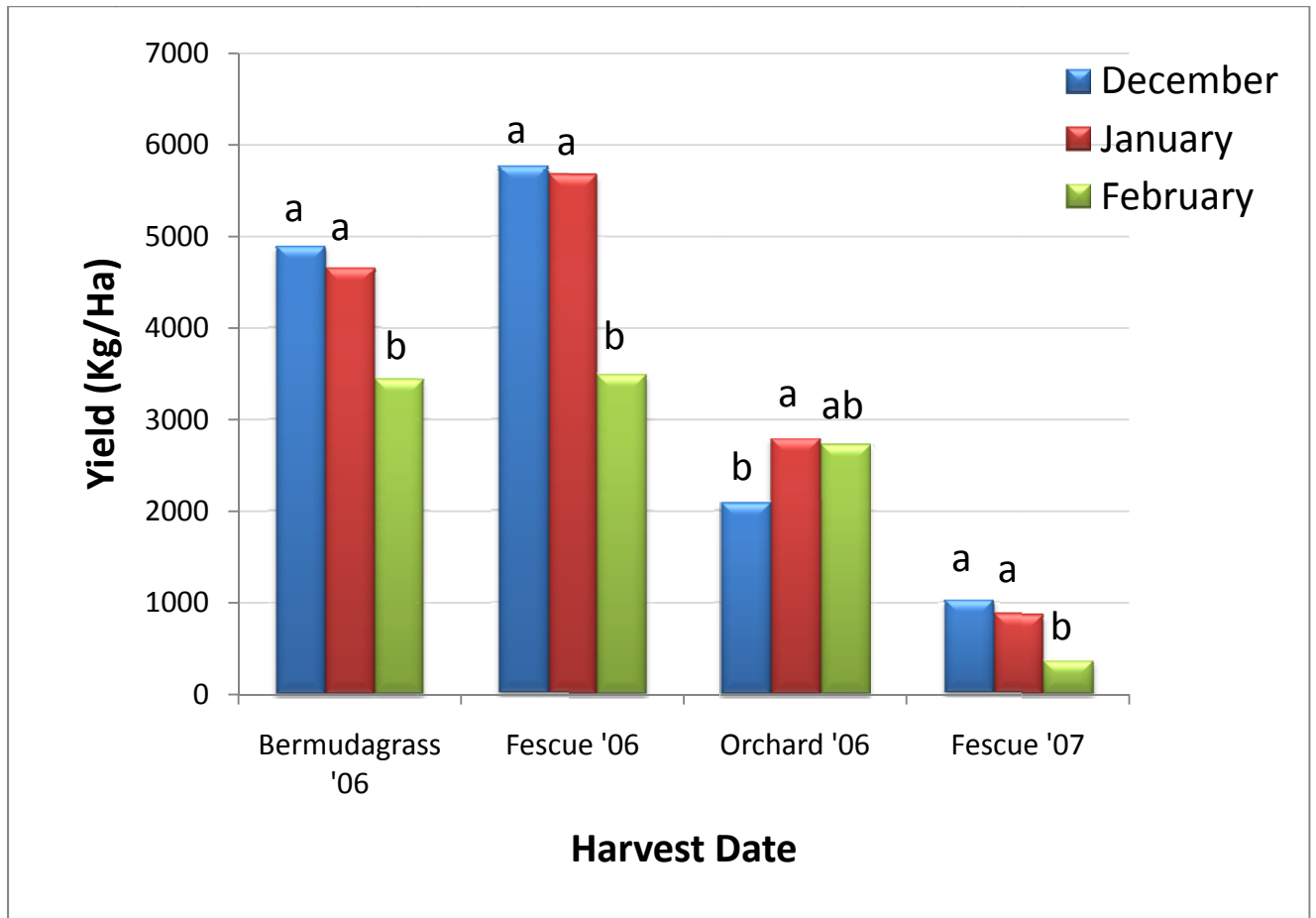


Figure 9. Effect of nitrogen fertilizer rate and harvest date on forage yield of grasses grown in Martin, TN in 2006 and 2007. Within grass species, means with the same letter are not significantly different by Tukey's Studentized Range Test ( $P \leq 0.05$ ).

(Table 3, Figure 10). The higher the amount of nitrogen applied, the greater the yield of the harvested forage. There were no significant differences in forage yield among the varieties in the fescue variety trial (Table 2). However, harvest date had a significant ( $P < 0.05$ ) effect on yield with yield decreasing from 730 kg/ha in December to 510 kg/ha in January. As expected, yield increased ( $P < 0.05$ ) from 596 kg/ha at 45 kg N/ha to 685 kg/ha at 135 kg N/ha (Table 2, Figure 11). There was a significant ( $p < 0.05$ ) linear increase in yield due to fertilizer rate among all forages.

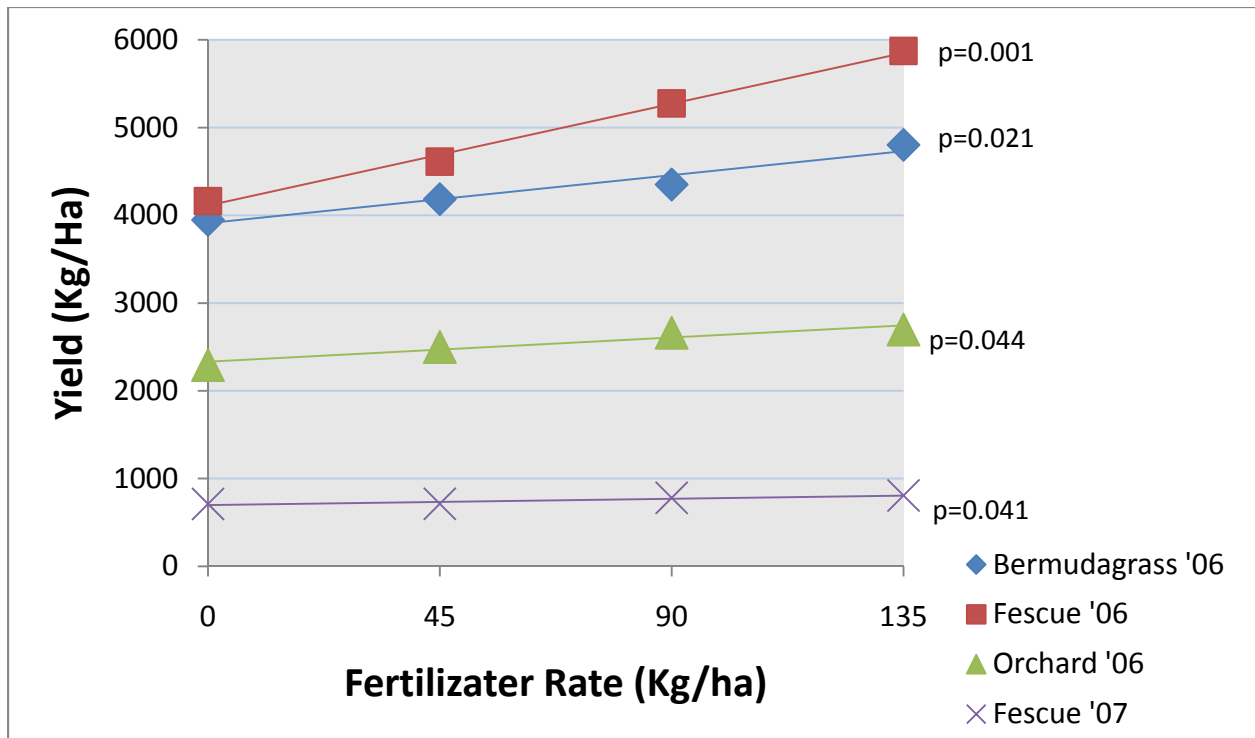


Figure 10. Effect of nitrogen fertilizer rate and harvest date of grasses grown in Martin, TN in 2006 and 2007.

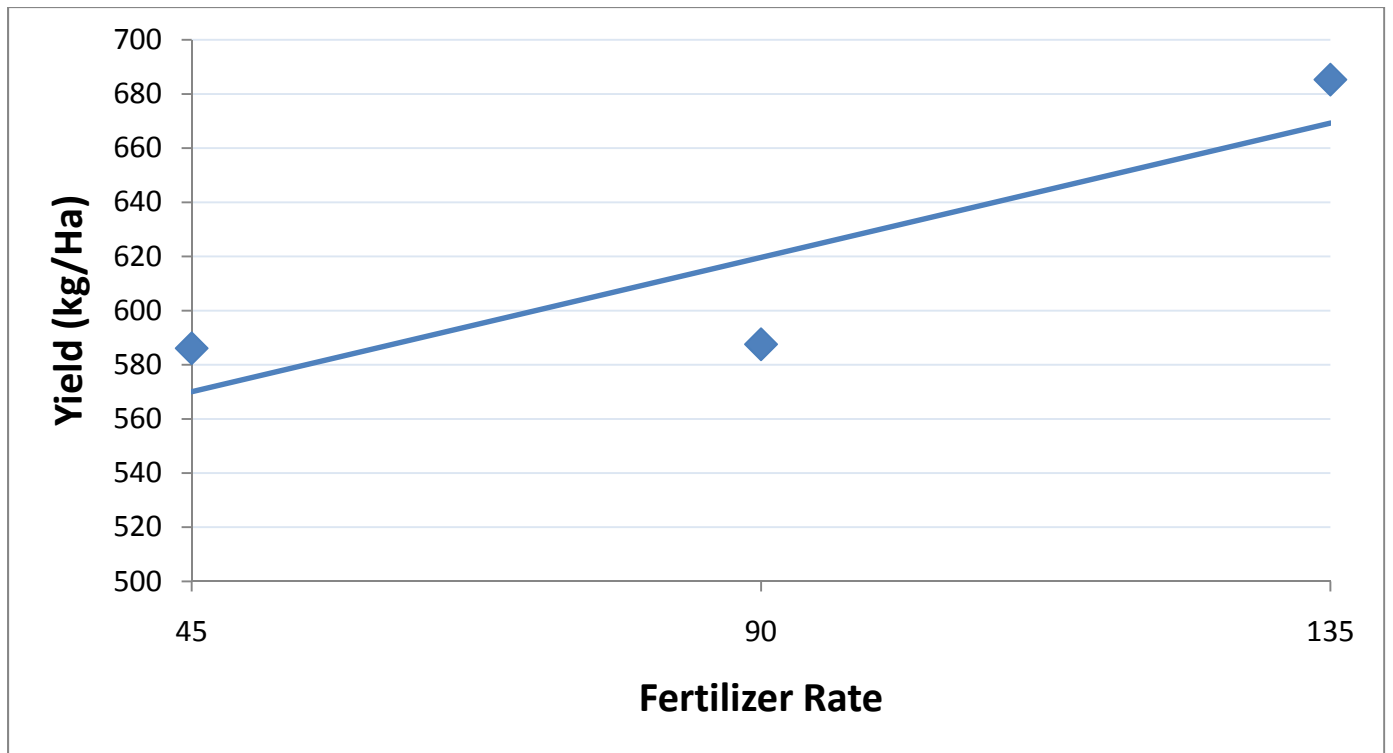


Figure 11. Effect of nitrogen fertilizer rate on tall fescue grown in Martin, TN in 2006 and 2007.

## **CHAPTER V - Conclusion**

With beef cattle producers looking for an alternative to a traditional forage program, stockpiling forages for winter grazing is a viable option. A producer must consider the grass species to be used for stockpiling. This research shows that an application of nitrogen fertilizer increased forage yields in all three species studied: tall fescue, Bermudagrass, and orchard grass. The highest yields were obtained with 135 kg of nitrogen fertilizer per hectare.

To maximize forage yield, with any of the grass species, the stockpiled grass should be harvested before February because forage yield was significantly greater in December and January.

## LITERATURE CITED

- Adams, Don C., Clark, Richard T., Coady, Sean A., Lamb, James B., Nielsen, Merlyn K. 1994. Extended grazing systems for improving economic returns from Nebraska sandhills cow/calf operations. *Journal of Range Management* 47: 258-263.
- Allen, V.G, Fotenot, J.P., Notter, D.R., Hammes, Jr., R.C. 1992. Forage systems for beef production from conception to slaughter: I. cow-calf production. *Journal of Animal Science* 70:576-587.
- Archer, K.A., and Decker, A.M. 1977 .Autumn-accumulated tall fescue and orchard grass. *Agronomy Journal* 69: 425-428.
- Balasko, J.A. 1977. Effects of N, P, and K fertilization on yield and quality of tall fescue forage in winter. *Agronomy Journal* 69: 425-428.
- Bryan, W.B., Wedin, W.F., and Veiter, R.L. 1970. Evaluation of reed canary grass and tall fescue as spring-summer and fall-saved pasture. *Agronomy Journal* 62: 75-79.
- Coblentz, Wayne, Coffey, Ken, Davis, George, and Turner, James. 1998. Evaluation of stockpiled bermudagrass after hay and pasture summer management. Arkansas Animal Science Department Report 43-47.
- Doss, B.D., Ashley, D.A., Bennett, O.L., Patterson, R.M. 1966. Interactions of soil moisture, Nitrogen, and clipping frequency on yield and nitrogen content of coastal Bermudagrass. *Agronomy Journal* 510-512.
- D'Souza, G.E., Maxwell, E.W., Bryan, Bryan, W.B., Prigge, E.C. 1990. Economic impacts of extended grazing systems. *American Journal of Alternative Agriculture* 58:120-126.
- Gerrish, Jim. 2005. Stockpiled forage's longevity. Beef Multiple databases.
- Hart, Richard H., Warren G. Munson, and Robert S. Lowery. 1970. Autumn-Saved Bermudagrass (*Cynodon dactylon* (L.) Pers.): effects of age and fertilization on quality. *Agronomy Journal* 61: 940-941.
- Hitz, A.C. and J.R Russell.1998. Potential of stockpiled forages in winter grazing systems for pregnant beef cows. *Journal of Animal Science* 76:404-416.
- Janovick, N.A., J.R. Russell, D.R. Strohbehn, D.G. Morrical. 2004. Productivity and hay requirements of beef cattle in a midwestern year round grazing system. *Journal of Animal Science* 82: 2503-2526.

- Kartchner, R.J. 1981. Forage intake and digestibility. *Journal of Animal Science* 51: 432-437.
- Lalman, D.L., C.M. Taliaferro, F.M. Epplin, C.R. Johnson, and J.S. Wheeler. 2000. Review: grazing stockpiled Bermudagrass as an alternative to feeding harvested forage. *Proceedings of the American Society of Animal Science*.
- Leidner, John. 2003. Your Cattle Pockets can Benefit from a Reserved Grass Supply. *Progressive Farmer* 118: 54.
- Patrico, Jim 2002. Put Your cows to work. *Progressive Farmer*. 117.SP5.
- Price, David. 1998. Fescue and year round grazing. *Beef* 34: 50.
- Scarborough, D.A., W.K. Coblenz, K.P. Coffey, and J.E. Turner. 2001. Effects of calendar date and summer management on the situ dry matter and fiber degradation of stockpiled forage from Bermudagrass pastures. *Journal of Animal Science* 79: 3158-3170.
- Scarborough, D.A., W.K. Coblenz, K.P. Coffey, and K.F. Harrison. 2004. Effects of nitrogen fertilization rate, stockpiling initiation date, and harvest date on canopy height and dry matter yield of autumn-stockpiled Bermudagrass. *Agronomy Journal* 96: 538-547.
- Schoonmaker, J.P., S.C. Loerch, J.E. Rossi, and M.L. Borger. 2003. Stockpiled forage or limit-fed corn as alternatives to hay for gestating and lactating beef cows. *Journal of Animal Science* 81: 1099-1104.
- Taliaferro, C.M., S.W. Coleman, P.L. Claypool. 1987. Relative winter forage quality of selected Bermudagrass cultivars. *Crop Science* 27:1285-1290.
- Taylor, T.H., and W.C. Templeton. 1976. Stockpiling Kentucky Bluegrass and tall fescue for winter pasturage. *Agronomy Journal*. 68: 235-239.

## **APPENDIX**

Table A.1 ANOVA Table for percent moisture of stockpiled Bermudagrass (2006)

Source	DF	Sum of Squares	Mean Square	F	Pr>F
Block	3	68.63	22.88	1.56	0.221
Month	2	149.74	74.87	2.33	0.179
Error a	6	193.09	32.18		
Rate	3	11.46	3.82	0.26	0.853
Rate*Month	6	39.12	6.52	0.45	0.842
Error b	27	395.13	14.63		

Table A.2 ANOVA Table for forage yield (Kg/ha) of stockpiled Bermudagrass (2006)

Source	DF	Sum of Squares	Mean Square	F	Pr>F
Block	3	2,745,935	315,312	1.81	0.169
Month	2	19,248,741	9,624,371	9.40	0.014
Error a	6	6,140,108	1,023,351		
Rate	3	4,687,540	1,562,513	3.09	0.044
Rate*Month	6	6,482,354	1,080,392	2.14	0.082
Error b	27	13,647,898	505,478		

Table A.3 ANOVA Table for percent moisture of stockpiled tall fescue (2006)

Source	DF	Sum of Squares	Mean Square	F	Pr>F
Block	3	41.29	13.76	0.54	0.662
Month	2	1,787.61	893.80	23.30	0.002
Error a	6	230.14	38.36		
Rate	3	562.20	187.40	7.29	0.001
Rate*Month	6	56.48	9.41	0.37	0.894
Error b	27	694.14	25.70		

Table A.4 ANOVA Table for forage yield (Kg/ha) of stockpiled tall fescue (2006)

Source	DF	Sum of Squares	Mean Square	F	Pr>F
<b>Block</b>	3	53,099,528	17,699,843	11.50	<.0001
<b>Month</b>	2	53,161,775	26,580,887	5.80	0.040
<b>Error a</b>	6	27,503,730	4,583,955		
<b>Rate</b>	3	20,287,622	6,762,541	4.40	0.012
<b>Rate*Month</b>	6	4,644,531	774,089	0.50	0.800
<b>Error b</b>	27	41,542,166	1,538,599		

Table A.5 ANOVA table for percent moisture of stockpiled orchard grass Trial (2006)

Source	DF	Sum of Squares	Mean Square	F	Pr>F
<b>Block</b>	3	16.08	5.36	0.58	0.636
<b>Month</b>	2	63.87	31.93	0.49	0.633
<b>Error a</b>	6	387.88	64.65		
<b>Rate</b>	3	254.95	84.98	9.12	0.0002
<b>Rate*Month</b>	6	31.65	5.27	0.57	0.754
<b>Error b</b>	27	251.59	9.32		

Table A.6 ANOVA Table for forage yield (Kg/ha) of stockpiled orchard grass (2006)

Source	DF	Sum of Squares	Mean Square	F	Pr>F
<b>Block</b>	3	3,750,901.29	1,250,300.43	4.93	0.007
<b>Month</b>	2	4,822,049.01	2,411,024.50	5.89	0.038
<b>Error a</b>	6	2,454,330.25	409,055.04		
<b>Rate</b>	3	128,566.75	409,522.25	1.61	0.209
<b>Rate*Month</b>	6	1,331,873.27	221,978.88	0.87	0.526
<b>Error b</b>	27	6,853,253.40	253,824.20		

Table A.7 ANOVA Table for percent moisture of stockpiled tall fescue (2007)

Source	DF	Sum of Squares	Mean Square	F	Pr>F
<b>Block</b>	3	2,589.71	863.24	22.38	<.0001
<b>Month</b>	2	1,503.78	751.89	7.59	0.023
<b>Error a</b>	6	594.24	99.04		
<b>Rate</b>	3	434.85	144.95	3.76	0.022
<b>Rate*Month</b>	6	32.88	5.48	0.14	0.989
<b>Error b</b>	27	1,041.63	38.58		

Table A.8 ANOVA Table for yield (Kg/ha) of stockpiled tall fescue (2007)

Source	DF	Sum of Squares	Mean Square	F	Pr>F
<b>Block</b>	3	581,730	193,910	11.60	<.0001
<b>Month</b>	2	3,768,559	1,884,280	19.41	0.001
<b>Error a</b>	6	582,473	97,079		
<b>Rate</b>	3	86,250	28,750	1.72	0.148
<b>Rate*Month</b>	6	175,213	29,202	1.75	0.002
<b>Error b</b>	27	451,388			

Table A.9 ANOVA Table for percent moisture of tall fescue variety trial (2007)

Source	DF	Sum of Squares	Mean Square	F	Pr>F
<b>Block</b>	3	137.33	45.78	1.67	0.196
<b>Variety</b>	2	401.56	200.78	3.58	0.095
<b>Error a</b>	6	336.17	56.03		
<b>Rate</b>	2	218.27	109.13	3.88	0.040
<b>Variety*Rate</b>	4	84.32	21.08	0.75	0.554
<b>Error b</b>	18	506.56	28.14		
<b>Month</b>	1	1,717.09	1,717.09	62.82	<.001
<b>Rate*Month</b>	2	40.34	20.17	0.74	0.488
<b>Var.*Rate*Month</b>	6	125.12	20.85	0.76	0.605
<b>Error</b>	27	738.04	27.33		

Table A.10 ANOVA Table for forage yield (Kg/ha) of tall fescue variety trial (2007)

Source	DF	Sum of Squares	Mean Square	F	Pr>F
Block	3	88,265	29,422	1.49	0.240
Variety	2	115,493	57,746	1.18	0.369
Error a	6	292,835	48,806		
Rate	2	155,122	77,561	3.97	0.037
Variety*Rate	4	59,770	14,942	0.76	0.562
Error b	18	351,729	19,540		
Month	1	872,440	872,440	44.09	<.0001
Rate*Month	2	38,120	19,060	0.96	0.394
Var.*Rate*Month	6	54,608	9,101	0.46	0.832
Error	27	534,267	19,788		