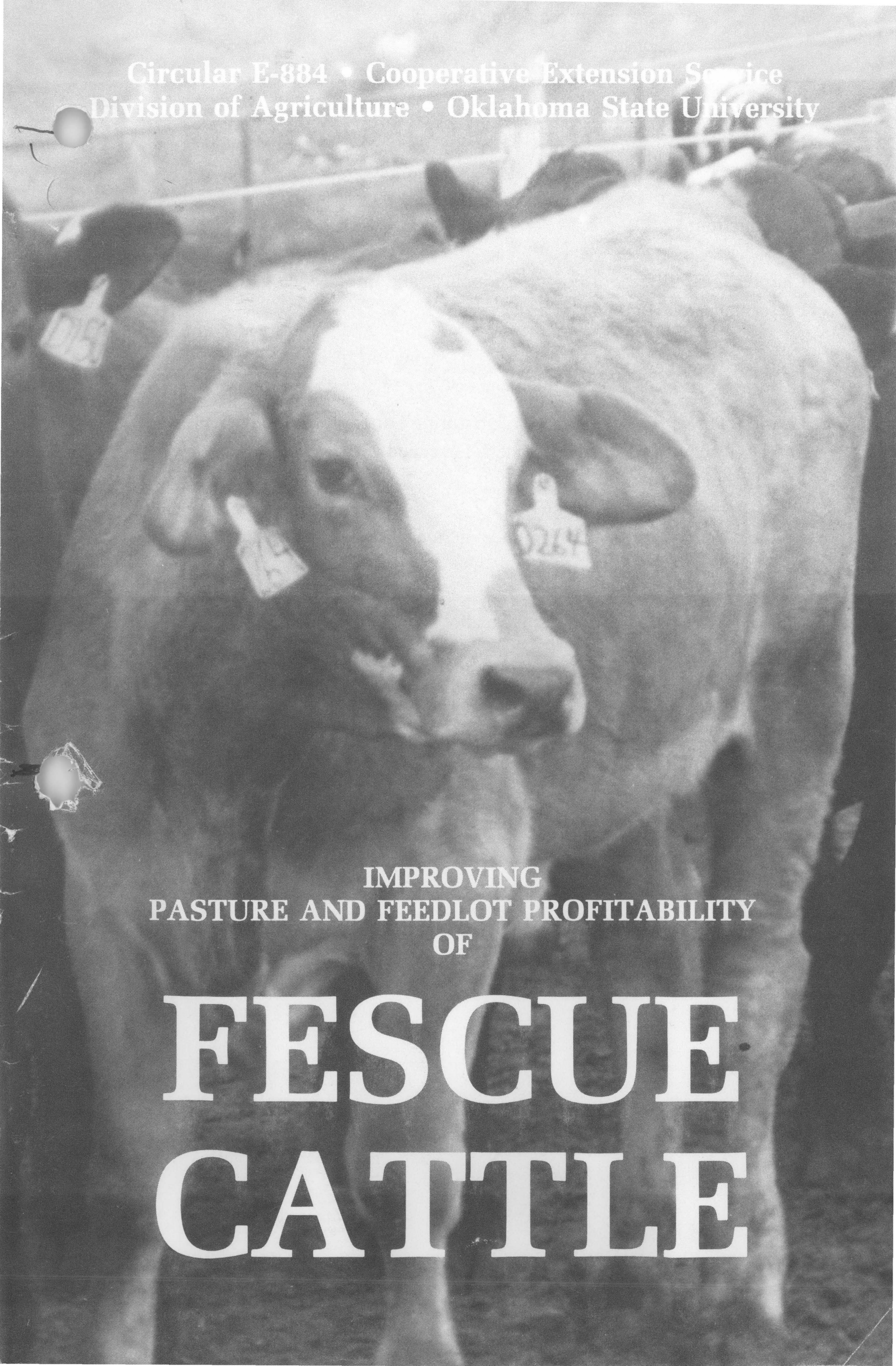

Circular E-884 • Cooperative Extension Service
Division of Agriculture • Oklahoma State University

IMPROVING PASTURE AND FEEDLOT PROFITABILITY OF

FESCUE CATTLE

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IMPROVING PASTURE AND FEEDLOT PROFITABILITY OF FESCUE CATTLE

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INTRODUCTION

Millions of acres in the United States are planted in tall fescue with an estimated one million acres of fescue in Oklahoma alone. Tall fescue is a cool season perennial grass that can provide grazing from fall to late spring with forage yields comparable to many summer grasses. Stands are easy to establish and maintain in areas suitable for fescue.

However, tall fescue has disadvantages that cost cattlemen millions of dollars each year. These losses take the forms of reduced animal performance and marketability.

The purpose of this publication is to summarize some of these problems, and provide an overview of research conducted by Oklahoma State University and others. Methods which may serve to minimize the negative effects of fescue on the grazing of stocker cattle in tall fescue and their

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subsequent finishing in the feedlot phase will be discussed. Economic evaluations of these practices will be presented.

The authors wish to express their appreciation to Mr. Steve Muntz of the Kerr Center, Inc., Poteau, Oklahoma for his highly professional management of the pasture studies. Likewise, a great debt is owed to Mr. Bill Skaggs, manager of the Henry C. Hitch Feedyard, Guymon, Oklahoma for his cooperation and expertise during the feedlot phase of this research.

THE PROBLEM IS FESCUE TOXICOSIS, BUT WHAT IS IT?

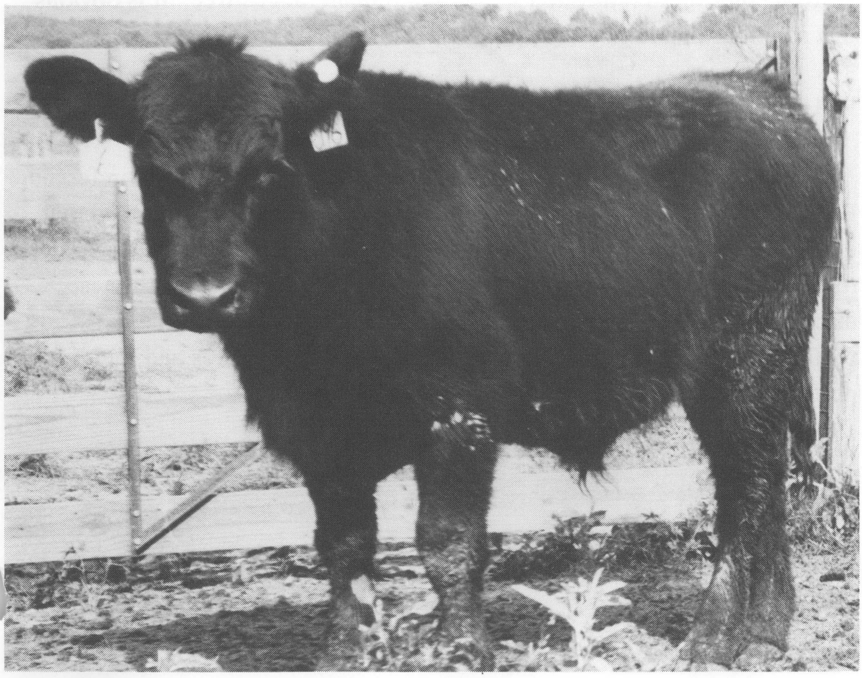
Fescue toxicosis in grazing cattle has been observed and studied by workers in Oklahoma, Arkansas, Georgia, Kentucky, Texas, Alabama and elsewhere. This work has generally isolated the problem and credited it to a fungus which can be found in the fescue plant. This fungus is referred to as the fescue endophyte (meaning 'in the plant').

This fungus, Acremonium coenophialum, resides in the seeds, stems and leaves. It offers the plant persistence, drought and insect tolerance. Unfortunately, alkaloids found in the plant when the fungus is present have toxic effects on animals which consume the infected fescue. These alkaloids, whose concentration is increased by nitrogen fertilization, cause detrimental effects on growing cattle, gestating and lactating cows, horses, and sheep.

The symptoms and effects of fescue toxicosis on grazing cattle include:

reduced forage intake
reduced daily gains
"fescue foot"
elevated body temperature
rough hair coats
excessive salivation
fat necrosis
increased heart and respiration rates
nervousness
increased morbidity and mortality due to marketing and shipping stress
reduced feedlot performance (if handled improperly)

All of the above symptoms of fescue toxicosis result in decreased production for affected animals. To compound the problem, the marketability of these animals is negatively affected because buyers do not want the uncertainty these animals present and will discount them severely. In Oklahoma, discounts as great as ten to fifteen dollars per hundred pounds are common.



Angus steer showing typical sings of fescue toxicosis. Note the rough hair coat and gaunt appearance.

ENDOPHYTE FREE FESCUE...THE SOLUTION?

Fescue varieties have been developed that do not contain the fungal endophyte. Long term storage of infected fescue seed has also been shown to alleviate the problem in plants grown from this seed. Cattle grazing the resulting fungus/endophyte-free plants do not exhibit the classic symptoms attributed to infected fescue but rather perform quite well.

Current recommendations are that any producer wishing to establish a new fescue pasture should use one of the endophyte-free varieties. However, there are serious problems in renovating an established fungus infected pasture to a fungus-free pasture.

Many current fescue pastures are such that complete renovation is prohibitive due to terrain, problems with eradication of the old fescue, or financial constraints. Also, for various reasons, there is currently some doubt as to whether these renovated stands will remain fungus-free. It is obvious that solutions in addition to expensive renovation be developed.

WHAT IS THE SOLUTION?

There is no simple answer to the problem of fungal endophyte in fescue. But the remainder of this publication will address research conducted that does offer some avenues which may serve to lessen the problems of fescue toxicosis on production and enhance profitability. Contained with these discussions will be information regarding breed differences in the performance of cattle grazing these different fescue pastures and their performance in the feedlot.

CHAPTER ONE

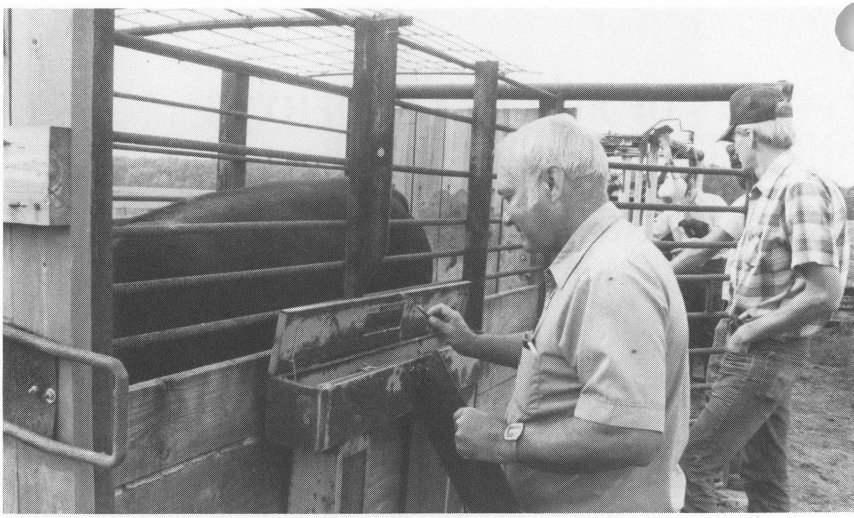
EFFECTS OF FESCUE ENDOPHYTE AND INTERSEEDED CLOVER ON STEER PERFORMANCE ON KENTUCKY 31 TALL FESCUE

SUMMARY

A 3-year study was conducted near Poteau in eastern Oklahoma to evaluate performance of stocker cattle grazing Kentucky 31 tall fescue. Three pastures were infected with high levels of the fescue endophyte, three pastures had endophyte-infected fescue overseeded with a clover mixture, while three other pastures contained zero to very low levels of the endophyte. A total of 173 Angus, Brahman x Angus, and Simmental x Brahman-Angus steers (7-12 months old) were used to study effects of these treatments on steer gain, appearance, health and cold temperature.

Steers of all three breeds gained faster on interseeded clover and low endophyte pastures than on the high endophyte fescue. However, the effect of the endophyte was not the same for all breeds. Brahman-Angus steers gained faster than Angus steers on all three pasture treatments, but the Brahman-Angus steers had an greater advantage over Angus steers on high endophyte fescue pasture (.62 lb/day), than on interseeded clover (.48 lb/day) or low endophyte fescue (.17 lb/day). Gains of Simmental x Brahman-Angus steers were similar to gains of Angus steers.

The greatest effect of the endophyte in reducing gains was seen during the period of mid-March to late-May. The endophyte caused increases in body temperature of the steers only in late-May, although the effect was not the same for all breeds. Temperatures of Brahman-Angus steers were not increased by grazing endophyte-infected fescue, but Angus and Simmental x Brahman-Angus had increased temperatures. Higher body temperatures were also seen with steers grazed on interseeded clover-fescue pastures although temperatures were not as elevated as on endophyte-infected fescue alone. Rough haircoats were pronounced on Angus and Simmental x Brahman-Angus steers grazing endophyte-infected fescue during April and May. Brahman-Angus steers were less affected. This appearance, typical of



cattle grazing infected fescue, was also seen in steers grazing the interseeded clover pastures, although to a much lesser degree.

This study shows that interseeding clover with endophyte-infected tall fescue can help overcome the detrimental effects of the endophyte on cattle gains. Breeds of cattle apparently differ in their ability to tolerate the toxic effects of the endophyte.

EXPERIMENTAL PROCEDURE

A total of 173 Angus, Brahman-Angus and Simmental x Brahman-Angus, 7 to 12 month old steers were used to study effects of grazing tall fescue on weight gains and rectal temperature. The study was initiated in the fall of 1985 at the Kerr Center, Inc. near Poteau in Eastern Oklahoma. All steers originated from the cow herd at the Kerr Center.

The three pasture treatments were:

(1) high endophyte (76% infected);
(2) high endophyte (74% infected) interseeded with clover;
(3) low endophyte (0.7% infected).

Three pastures of each forage treatment (total of nine pastures) were randomly arranged in a wagon wheel design around a set of working and weighing facilities. Pasture sizes varied from 11 to 14 acres. The soil is Neff silt loam. Endophyte infection rate was determined from seed samples taken throughout the pastures in early June of 1985, 1986, and 1988. Seed samples were analyzed by the Fescue Toxicity Diagnostic Center, Auburn University, Auburn, AL.

The entire area had an old established stand of Kentucky 31 tall fescue. Low endophyte pastures were established by spraying three times with Paraquat beginning in the spring of 1984 to prevent seed production, followed by moldboard plowing, and seeding with one-year-old Kentucky 31 tall fescue testing 0% live endophyte. Soil pH, P and K were maintained according to soil test recommendations. The interseeded clover treatment received no N fertilizer, but both the high and low endophyte treatments received 100 lb actual N per acre each September. The interseeded clover pastures were overseeded each September with Redland red clover, Regal ladino clover, and Yuchi arrowleaf clover. Red clover became the dominant clover.

All steers were implanted with Ralgro each year at the beginning of the grazing study and again at the March weighing. Average beginning steer weights were 484, 497, and 541 lb for 1985-87, respectively. Grazing began about November 5 and ended about May 20 for a 196-day period. Weights were taken following overnight withdrawal from feed and water at 42-day intervals except for the final period which lasted 28 days. Supplemental bermudagrass hay was fed when snow and ice occurred although an average of only 99 lbs/steer was fed each year. Stocking rates were adjusted by adding or removing extra steers in order to equalize forage availability between pastures and also to better utilize the spring growth. Only data from steers maintained on the pastures throughout the season were used for record.

Rectal temperatures were taken with an electronic digital thermometer on the final weigh date the first year and at every weigh date during years 2 and 3. Weighing was completed before 10:00 a.m. and the order in which pasture groups were weighed was arranged to minimize bias because of the natural rise in body temperature during the day.

RESULTS

Weight Changes

Average daily gains for each weighing period are shown in Table 1. Because the effect of pasture treatments was not the same for all breeds, daily gains for each breed and treatment combination are shown. The interaction between treatment and steer breed for daily gain was significant for the total grazing period and for 3 of 5 intermediate periods. Steers of all three breeds gained faster for the total grazing period on low endophyte and interseeded pastures than for high endophyte pastures. Brahman-Angus steers gained faster than Angus on all three pasture treatments but Brahman-Angus steers exhibited a greater advantage over Angus steers on the high endophyte pasture (.62 lb/day) than on interseeded (.48 lb/day) or low

Table 1. Daily gains (lb) for Angus (AN), Brahman x Angus (BA) or Simmental x Brahman-Angus (SxBA) steers grazing high endophyte (HE), low endophyte (LE) or high endophyte fescue interseeded with clover (IS).

		Grazing Period Ending Date[b]					
Treatment	Breed	18Dec	29Jan	12Mar	23Apr	20May	Total
HE	AN	1.96^{cd}	$.95^{c}$	$.66^{c}$	1.32^{c}	$.73^{c}$	1.14^{c}
HE	BA	2.46^{e}	1.39^{ef}	1.08^{ef}	2.09^{d}	1.89^{ef}	1.76^{de}
HE	SxBA	1.62^{c}	$.90^{c}$	$.86^{cd}$	1.45^{c}	1.21^{d}	1.21^{c}
IS	AN	2.42^{e}	1.43^{ef}	1.23^{ef}	2.22^{d}	1.68^{de}	1.78^{e}
IS	BA	2.88^{f}	1.66^{f}	1.50^{f}	2.63^{e}	2.72^{h}	2.26^{g}
IS	SxBA	1.71^{c}	$.86^{c}$	1.28^{ef}	2.26^{c}	2.11^{fg}	1.61^{d}
LE	AN	2.90^{f}	1.25^{def}	$.81^{d}$	2.09^{d}	2.46^{fg}	1.87^{e}
LE	BA	3.01^{f}	1.47^{de}	1.10^{e}	2.11^{d}	2.81^{h}	2.04^{f}
LE	SxBA	2.06^{d}	$.99^{cd}$	$.79^{d}$	2.22^{d}	2.44^{gh}	1.65^{d}
Significance[i]							
Treatment		*	NS	*	**	**	**
Breed		**	**	**	**	**	**
Treatment x Breed		NS	*	NS	**	*	**

[a]3-year means[a].

[b]Grazing periods were 42 days except the last, which was 28 days.

[cdefgh]Means in a column with different superscript letters differ ($P<.05$).

[i]*,**Indicate significance at the 0.05 and 0.01 probability levels, respectively, NS = not significant.

endophyte pastures (.17 lb/day). Compared to Angus steers, daily gains of Simmental x Brahman-Angus steers for the total grazing period tended to be greater on the high endophyte pasture (+.07 lb/day) but were lower on interseeded clover and low endophyte pastures (-.17 and -.22 lb/day, respectively).

In general, steers grazing low endophyte and interseeded clover pastures gained faster at each intermediate weighing than high endophyte steers. The greatest differences were observed during the periods from mid-March to late-May. Smaller differences in favor of low endophyte and interseeded clover treatments compared to high endophyte were seen during the November to mid-December and mid-January to mid-March periods. Pasture treatment differences were not different during the mid-December to late-January period. These observations strongly suggest that season and/or temperature influenced the effects of endophyte toxins in these tall fescue pastures. Brahman-Angus steers gained significantly faster than Angus or Simmental x Brahman-Angus steers at every intermediate period.

Significant breed x treatment interactions occurred during the 2nd, 4th, and 5th periods. A breed x treatment interaction means that all breeds did not respond the same to the different pasture treatments. The relative gain advantage for Brahman-Angus compared to Angus and Simmental x Brahman-Angus steers were greater on high endophyte and interseeded clover pastures than on low endophyte pastures.

Body Temperatures

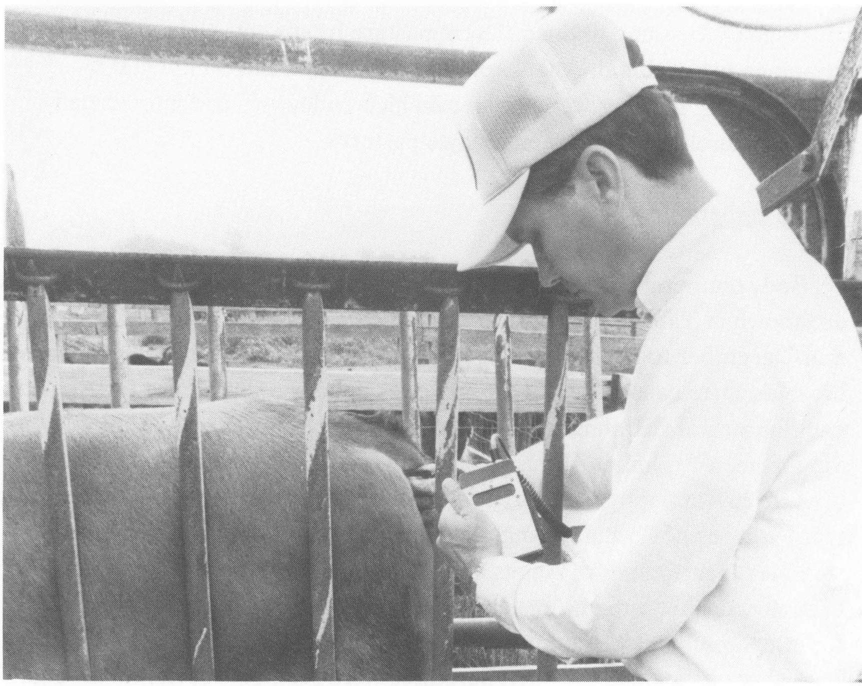
Body temperatures for the different pasture treatments and cattle breeds are shown in Table 2. No differences in body temperature were detected at mid-December to late-April weigh dates. However, on May 20, presence of the endophyte caused significant increases in body temperature for Angus and Simmental x Brahman-Angus steers. Temperatures of Angus and Simmental x Brahman-Angus steers were higher for high endophyte pastures than for low endophyte pastures with interseeded steers intermediate. Rectal temperatures of Brahman-Angus steers were not affected by pasture treatment. A number of Angus and Simmental x Brahman-Angus steers exhibited rectal temperatures above 106 F with the highest being 107.3 F for one Simmental x Brahman-Angus steer in 1987.

Although elevated body temperatures were seen only at the final weigh date on May 20, reduced steer gains caused by the high endophyte occurred on 4 of 5 weigh dates. Thus, while elevated body temperature is a symptom

Table 2. Rectal temperatures (F) on May 20 for Angus (AN), Brahman x Angus (BA) and Simmental x Brahman-Angus steers (SxBA) grazing high endophyte (HE), low endophyte (LE) or high endophyte fescue interseeded with clover (IS).

	Breed		
	AN	BA	SxBA
Treatment			
HE	104.2[e]	102.7[c]	103.3[d]
IS	103.6[d]	102.8[c]	102.7[c]
LE	102.0[b]	102.5[bc]	102.4[bc]
Significance[e]			
Treatment	P<.01		
Breed	P<.01		
Treatment x Breed	P<.01		

[a]3-year means.[a]
[bcd]Means on a line or column with different superscript letters differ (P<.05).
[e]*,**Indicate significance at the 0.05 and 0.01 probability levels, respectively, NS = not significant.



Rectal temperatures are elevated in warm weather when cattle graze on endophyte-infected fescue.

of fescue toxicosis, gains can be reduced by the endophyte without body temperature being affected. Highest gains were seen with steers grazing interseeded clover although their body temperatures were intermediate between high endophyte and low endophyte.

It appears that elevated body temperatures occur only when environmental temperatures begin to exceed 80 F in May and that the effect of the endophyte is in restricting the body's ability to control body temperature. That is to say that these cattle did not have a true fever, but rather could not control their body temperature when the environmental temperature was high. These findings agree with Kentucky research that has shown the effects of fescue endophyte on forage intake and body temperature to be more pronounced at higher environmental temperatures.

It is important to note that the Brahman-Angus steers did not have elevated body temperatures which were characteristic in the Angus and Simmental x Brahman-Angus steers in May. This suggests that the heat tolerance of Brahman cattle may somehow permit these cattle to overcome some of the detrimental effects of the endophyte toxins.

Stocking Rates

Stocking rates were determined following visual appraisals of quantity of forage available. High endophyte pastures had the highest stocking rates and still had excess forage in the spring. The presence of excess forage in spring for the high endophyte pasture should not, however, necessarily be interpreted as meaning that high endophyte fescue produced more forage than low endophyte fescue. A number of studies have shown that the presence of endophyte in fescue causes decreased forage intake. Further, the degree of intake depression is greater when cattle are exposed to warmer temperatures.

An excellent stand of red clover was maintained in the interseeded clover pastures; and while individual steer gains were similar to those on the low endophyte, stocking rates were less on interseeded clover until mid-April. This is because nitrogen fertilization could not be used during the fall with clover present in the pastures. Mean stocking rates were .86, .68 and .76 steers per acre for high endophyte, interseeded clover and low endophyte, respectively. This would give an estimated 232, 252, and 277 lbs/acre gain for the high endophyte, interseeded clover, and low endophyte, respectively.

Grazing was terminated each year about May 20 because: (1) the cattle from high endophyte gained so poorly during the last weigh period and were

Palatability differences between endophyte-infected pasture on the left and endophyte-free on right are obvious in May. Note how the forage on the right is grazed closely.

visibly affected by fescue toxicosis, (2) many of the other cattle were weighing over 880 lbs and were ready for the feedlot, and (3) growth rate and quality of the pastures were deteriorating. No visible evidence of stand deterioration was noted in the low endophyte pastures throughout the study.

CONCLUSIONS

In conclusion, Brahman-Angus steers gained faster on high endophyte and interseeded pastures than the Angus steers, and the advantage of Brahman-Angus steers was less on low endophyte pasture. Steer gains were similar on interseeded and low endophyte pastures; thus, the clover had a very positive effect in reducing the effect of the endophyte. Elevated body temperature did not occur in the Brahman-Angus steers, but did occur in Angus and Simmental x Brahman-Angus steers only on May 20, indicating that environmental temperature may be influencing body temperature. Reduced steer gains from high endophyte occurred throughout most of the grazing season without elevated body temperatures.

CHAPTER TWO

FESCUE PASTURE MANAGEMENT

INTRODUCTION

Research conducted by Oklahoma State University over a three year period has shown differences in performance when steers were grazed on high endophyte, low endophyte or high endophyte pastures interseeded with clover. Beef cattle producers have an opportunity to use tall fescue in wintering beef cattle. This opportunity offers lower winter feed costs over traditional supplementation feeding methods and under certain management schemes, offers gains to stocker cattle comparable to what might be expected on wheat pasture. Since tall fescue is a perennial forage, a substantial savings in annual establishment costs can be realized as compared to small grains forages such as wheat and rye which must be planted annually.

SEEDING LEGUMES INTO ESTABLISHED FESCUE PASTURES

Legumes interseeded into tall fescue pastures offer several advantages over tall fescue alone. Some of the more notable advantages are:

1. Legumes dilute the effects of the fungal endophyte found in high endophyte pastures.

2. Legumes have bacterial (Rhizobia) colonies growing on their roots that convert nitrogen into a form usable by the legume plant. This so-called free nitrogen is eventually recycled through the plant-soil environment and may become available to other plants such as tall fescue or bermudagrass. However, this process is not very efficient as far as the grass is concerned so that total forage production is usually somewhat lower than is commonly obtained under high rates of nitrogen fertilization. Thus, legumes offer a partial substitute for nitrogen fertilization.

3. Legumes are normally high quality forages. This is particularly true of the cool season legumes. It is not unusual for cool season legumes to have crude protein levels of 15-30%.

There are also limitations to growing legumes in eastern Oklahoma. Some of the limiting factors may include:

1. A near neutral soil pH, readily available soil phosphorous and potassium, are all necessary for sustained legume growth and production.

The pH of many surface soils in eastern Oklahoma is often below 6.0. This acid environment is not conducive for the growth and multiplication of nitrogen-fixing bacterial colonies on the roots of legumes. The only way to correct an acid soil condition is the application of agricultural limestone. This can cost in excess of $30.00 per acre. Of course, correcting an acid soil condition will not only benefit legumes but also other forages such as grasses.

Soil available phosphorus and potassium are often limiting for production of commonly grown forages. The correction of these limitations through application of fertilizers or manures is essential for higher production. Legumes must have a ready supply of available nutrients in the soil around the root hairs. Occasionally, other nutrients such as magnesium, sulfur, and boron may not be present in sufficient amounts for legume growth. The only way to correctly determine the nutrient needs of the crop in question is through a laboratory analysis of a properly collected soil sample. This should be the first step in determining the feasibility of planting legumes.

2. Most legumes are temperamental in their growth habits. They are very sensitive to extremes in weather such as prolonged drought or waterlogged soils. Most of the legumes that would be considered as possible companion crops to tall fescue are winter annuals; in other words, they come up from seed in the fall and complete their life cycle in the spring by flowering and maturing seed. Any situation such as a dry fall will delay their germination or reduce fall forage production. White (ladino) clovers and red clovers are perennials in growth habit. They survive through the summer and resume growth in the fall with the arrival of cooler temperatures and fall rains. Red clovers are typically short-lived perennials in Oklahoma and might need to be reseeded every couple of years.

3. Legumes are sensitive to shade, especially when they are germinating and beginning to grow. Therefore, grasses into which clovers are seeded, must be mowed or grazed closely prior to germination of the legumes. This can be a potential problem to the producer who wishes to stockpile fescue forage in the fall to be used later. Stockpiling has a very negative effect on young legume seedlings.

4. Most legumes should be grown on well drained soils. White clovers, such as Ladino, are well adapted to poorly drained soils. However, most other commonly grown legumes in eastern Oklahoma will not tolerate prolonged wet soil conditions. Tall fescue grows very well on wet, poorly drained soils and often does not survive the summer when planted on droughty, sandy soils. Therefore, choosing a site where legumes, as well as

tall fescue thrive, can sometimes be challenging. The ideal soil for growing tall fescue and a cool season legume would have good internal drainage. River or creek bottom soils that frequently flood for extended periods may have difficulty maintaining legume stands.

RECOMMENDED LEGUMES FOR INTERSEEDING WITH TALL FESCUE

Arrowleaf clover- This clover is a winter annual that reseeds itself very well, and is capable of producing a great deal of forage during April and May. Arrowleaf clover should be planted in September-October with a seeding rate of 4-6 lbs per acre. Once a stand is established and reseeds, it should volunteer indefinitely.

Red clover- There are several varieties available with Kenland the most popular variety. Red clover should be planted in the fall with a seeding rate of 8-10 lbs per acre. Red clover will produce some forage during the summer, especially if the summer is not unusually hot and dry.

White clover- White clover is a perennial legume that may live many years and is adapted to low, wet areas. Ladino and Louisiana S-1 are common varieties. A new release from Florida is called Osceola. Pure stands of white clover may cause bloat, especially in the spring, but bloat is usually not a problem in a mixed diet of other forages. Seeding rate for the white clovers is 1-3 pounds per acre.

Subterranean clover- The so-called "sub" clovers are productive legumes that grow very low to the ground. Subterranean clover reseeds itself very well due to its unique ability to develop seed pods right on the soil surface. Once established, it is very prolific. Subterranean clover reportedly grows fairly well in a slightly acid soil environment (pH 5.5-6.0) and grows well under shade making it compatible with taller grasses. It even grows well under tree canopy. Seeding rate is 6-10 pounds per acre.

Crimson clover- The earliest maturing clover in the spring, crimson grows rapidly in the fall if growing conditions are good. Due to its earliness, total forage production may be limited. However, it could work well in combination with tall fescue if the cattle were removed by mid-April when the weather begins warming. Dixie and Tibbee are two hard-seeded varieties. One of these should be planted if reseeding is desired. Plant 10-15 pounds of seed per acre in the fall.

Hairy vetch- A good reseeder and very productive, hairy vetch will return high amounts of nitrogen to the soil if properly inoculated. Some producers complain that their cattle do not like to graze vetch, but nevertheless, it could work well in combination with tall fescue and possibly other legumes. Plant 15-25 lbs per acre in the fall.

INOCULATING LEGUME SEED

Common causes of failure in legume seedings are either failure to inoculate the seed at planting or if the seed is inoculated, the inoculation is not successful. The Rhizobial bacteria that are necessary for nitrogen fixation are, like other living organisms, very susceptible to environmental extremes. High temperatures, rapid drying and ultraviolet radiation all can kill the bacteria before they have time to initiate the formation of nodules on the root of the seedling legume. Care should be taken when handling inoculates. Always keep the bag cool and in a shaded area until ready for use. Even then, planting into a hot, dry seedbed can result in the loss of substantial numbers of bacteria. The best recommendation is to always plant ahead of a good rain.

CLOVER-TALL FESCUE COMBINATION PASTURE COSTS

Before initiating any change in management, the prudent producer will evaluate all costs associated with the change and compare those costs to the expected outcome. Other options should be carefully evaluated before a final decision is made. The decision to interseed clover into existing fescue sod should be evaluated on the basis of the initial investment and the annual expenditures necessary for maintaining the clover-tall fescue combination. An example budget for the estimation of maintaining clover-fescue pastures is shown in Table 3.

ESTABLISHMENT OF LOW-ENDOPHYTE PASTURES

Variety Selection

Following the recognition of the fungal endophyte problem in tall fescue, there has been a great deal of effort to alleviate the problem. One of the ways is to plant fescue seed that is not infected with the fungus. Since it has

Table 3. Annual maintenance costs of clover-tall fescue pastures.

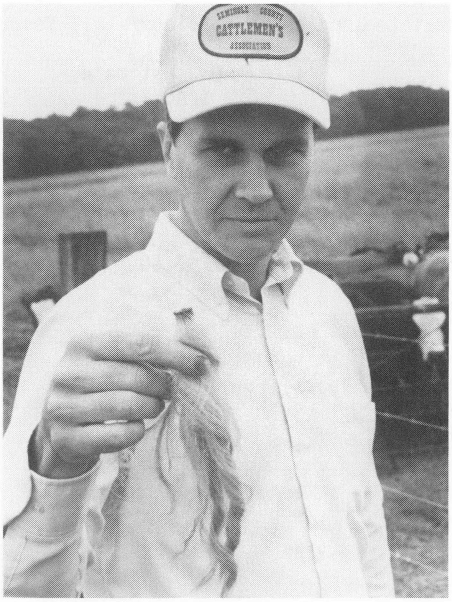
Item	OSU Estimate $/Ac/Yr	Producer $/Ac/Yr
Equipment, labor (broadcast/no till drill)	2.50	______
Ag limestone (1 application/seven years)	7.50	______
Phosphorus and Potassium (annually)	12.50	______
Seed (reseed every three years)	3.00	______
TOTAL	25.50	______

been shown that plants from uninfected seeds will always remain uninfected, the development of fungus-free seedstock became a priority. At the present time there are several fescue varieties on the market that are free of the fungus. Some of the recommended varieties are:

Johnstone
AU Triumph
Mozart
Martin

In addition, seed of Kentucky 31 and Kenhy varieties are available that are certified to be fungus-free. However, the producer must be alert to the fact that a small contamination of infected seed in a seed lot may eventually lead to a large contamination in a field. Remember that the fungus or endophyte makes the fescue plant more drought and insect tolerant as well as less prone to overgrazing. Therefore, one should purchase seed which specifically states on the seed label that it is Certified Endophyte Free.

Other varieties of fungus-free seed are also available but the forage producing value has not been proven. A producer would certainly not want to plant a fungus-free variety only to find out at a later date that the forage production potential and/or adaptability is less than expected.



Tail losses are common on endophyte-infected fescue pastures. The toxin cuts off blood supply above the switch.

RENOVATION OF AN EXISTING STAND

It has been shown through laboratory testing that a very large percentage of established fescue pastures are infected to some extent with the fungal endophyte. It would be desirable to "clean up" these pastures either by some treatment of the existing stand or by elimination of the existing stand and the replanting of the field to fungus-free plants.

Unfortunately, both of these proposals have proven to be very difficult. First, there is no known method whereby infected plants in the field can be effectively rid of the fungus. The fungus grows within the plant (endophyte) and has been very resistant to any type of fungicide treatment.

Second, destruction of an existing stand of tall fescue seemed to be a very straightforward procedure a few years ago. Early treatments with the herbicide "Gramoxone" (Paraquat) were very effective in "burning back" the foliage. A couple of treatments seemed to do the job. "Roundup" herbicide was also used with some success. However, most of the herbicide treatments alone have not given long-term control. One problem is that new seedlings have emerged from seed that was already on the soil at the time treatments were made. Tall fescue seeds apparently remain viable in the soil longer than was previously thought.

One of the most effective methods of fescue eradication has been a fall "Gramoxone Super" treatment followed by a spring "Gramoxone Super" treatment. Multiple discings are then performed that summer. Endophyte-free tall fescue seed can be planted in the fall or, more preferably, small grains are planted the first fall and plowed under the following spring before "stray" tall fescue seedlings have a chance to produce seed. A summer hay or forage crop such as millet or sudangrass can be planted during the summer. Endophyte-free tall fescue would then be planted in the fall with little chance of contamination from infected seeds. A budget for this treatment is outlined in Table 4.

Table 4. Estimated cost for destroying an infected stand of tall fescue.

Treatment	OSU Estimate $/Acre	Producer Estimate $/Acre
Gramoxone Super (fall) @ 2 1/2 pints + surfactant	10.50	________
Gramoxone Super (spring) @ 2 1/2 pints + surfactant	10.50	________
3 summer discings	18.00	________
TOTAL	39.00	

ESTABLISHMENT OF NEW ENDOPHYTE-FREE PASTURES

Planting - Tall fescue should be planted in the fall. September 15-October 15 is the preferred planting period. Spring plantings are sometimes attempted but are not as successful as fall. As with any forage crop, a good, well-prepared seedbed is desirable. Ag lime, phosphorus and potash, should be applied according to a soil test recommendation and should be applied during seedbed preparation and worked into the soil. Starter nitrogen can be applied either before or immediately after planting. Tall fescue is sometimes planted through a sod drill without any seedbed preparation. This method usually results in a thinner stand than if planted on a prepared seedbed. Competition from existing vegetation for water, nutrients, and sunlight can reduce the number of seedlings that survive. Also, the opportunity to incorporate plant nutrients may not be available unless the sod drill has a fertilizer box. Many producers do not want to bother with trying to apply fertilizer through a drill. Estimated costs for clean tilled and no-tilled establishment are shown in Tables 5 and 6.

Weed Control - Weed control is usually not a major problem for fall-seeded tall fescue plantings. Volunteer annual ryegrass and various annual bromegrasses may provide competition to the young seedlings. There are no herbicides that will selectively remove these plants from a new fescue seeding. Flash grazing can be used to remove any excess annual grass growth to give fescue seedlings a chance to compete. Broadleaf weeds are seldom a major problem in fall seeding but, 2, 4-D Amine applied on a warm afternoon after the fescue is well established may provide adequate control. Spring seedings are very susceptible to competition from weedy grasses and broadleaf weeds. Consequently, it is recommended that seedings be done in the spring only as a last resort.

Table 5. Tillage method of establishing an endophyte-free fescue pasture.

Treatment		OSU Estimate $/Acre	Producer Estimate $/Acre
Fuel		13.50	________
Repairs		4.25	________
Seed (20#/acre)		23.00	________
Fertilizer		25.00	________
Labor (2 hours)		12.00	________
	SUBTOTAL	77.75	________
Lime		18.00	________
	TOTAL	95.75	________

Table 6. No-till method of establishing an endophyte-free fescue pasture.

Treatment		OSU Estimate $/Acre	Producer Estimate $/Acre
Gramoxone Super @ 1 1/2 pints/acre		6.00	_______
Custom No-Till		10.00	_______
Seed (20#/acre)		23.00	_______
Fertilizer		25.00	_______
Labor		6.00	_______
	SUBTOTAL	70.00	_______
Lime		18.00	_______
	TOTAL	88.00	_______

First Year Management - Since tall fescue is a perennial grass, it must have time to develop an adequate root system prior to hot, dry summer conditions. If it is grazed too closely during the first winter, the root system may not be developed well enough for the planting to survive the first summer or at the very least, substantial numbers of seedlings may not survive leaving only a marginal stand. This appears to be especially true of the endophyte-free varieties. Numerous observations of endophyte-free varieties across the fescue belt have shown that they may be more susceptible to overgrazing, weather extremes (hot,dry), and even insect damage. Proper management can minimize these potential problems. For the first year, it is probably best not to graze the stand at all. It is also important in succeeding years to leave some standing forage (4-6 inches) before the onset of summer.

MAINTENANCE COSTS OF FESCUE PASTURES

The decision to establish new endophyte-free fescue pastures, to renovate existing stands with interseeded clover, to reestablish to endophyte-free varieties or make do with pastures as they are should be based on economic considerations. These decisions should weigh benefits to animal performance against renovation/establishment costs and annual maintenance costs.

Tables 3, 7, and 8 contain estimates of the annual upkeep costs for pastures of endophyte-infected fescue interseeded with clover, endophyte-free fescue, and existing endophyte-infected fescue. Readers are encouraged to review the included OSU estimations and then calculate costs based upon local costs, soil test recommendations, and advice from extension personnel.

Table 7. Annual maintenance costs of endophyte-free fescue pastures.

Item	OSU Estimate $/Ac/Yr	Producer $/Ac/Yr
Nitrogen (100# N @ $18.00/cwt)	18.00	______
Phosphorus, Potassium	12.50	______
Cost of Establishment (over 7 years, No-till, not including one year deferred grazing)	12.57	______
TOTAL	43.07	______

Table 8. Annual maintenance costs of pre-existing endophyte-infected pastures.

Item	OSU Estimate $/Ac/Yr	Producer $/Ac/Yr
Nitrogen (60# N @ $18.00/cwt)	10.80	______
Phosphorus, Potassium	12.50	______
Annual fall clipping	3.00	______
TOTAL	26.30	______

CHAPTER THREE

THE ECONOMICS OF PASTURING CATTLE ON ENDOPHYTE-INFECTED FESCUE, ENDOPHYTE-INFECTED FESCUE INTERSEEDED WITH CLOVER, OR ENDOPHYTE-FREE FESCUE PASTURES

INTRODUCTION

Although the purpose of the research carried out in Poteau, Oklahoma was primarily to investigate the effects of the fescue endophyte on the performance of grazing cattle, significant light can be shed on the economic effect of the endophyte. These observations may serve as an aide to future decisions concerning the management of cattle on these infected pastures.

The economic impact of fescue toxicosis is significant. This is due not only to the reduced performance of cattle grazing endophyte-infected fescue but also to their reduced marketability. Cattle exhibiting severe symptoms of fescue toxicosis can receive discounts of up to fifteen dollars per hundred in relation to cattle of comparable weights.

For the purpose of this discussion, the advice of qualified OSU Extension personnel and cattle buyers involved in S.E. and Central Oklahoma livestock markets was obtained. Information regarding cattle prices was also garnered from the Wall Street Journal and the Oklahoma Market Report published by the Oklahoma State Department of Agriculture. This information was used to develop the pricing structure used in generating economic data for the steers used in this research. The price structure is contained in Table 9.

Realistic production costs were used to determine net profits of cattle grazing the different treatments. These out-of-pocket production costs include OSU estimations for the maintenance or renovation of infected pastures using timely seed, fertilizer, equipment and chemical costs. These costs can be found throughout this bulletin. As often as possible, spaces are provided for the reader to list costs more applicable to his operation.

Profitability on a per head basis was determined by use of a computer budget designed by OSU personnel. The purpose of this budget is to

Table 9. Cattle price structure used in profitability calculations.

Weight	English & Exotic crosses, $/cwt	Brahman crosses, Engligh or Exotic $/cwt	Cattle w/ Symptoms of Fescue Toxicosis, $/cwt
400	105	95	
450	100	90	
500	95	85	
550	92.50	83	
600	90	82	77
650	87.50	80	74.50
700	85	78	72
750	82.50	76.50	71
800	80	75	70
850	79	74.5	69
900	78	74	
950	77	73.50	
1000	76	73	
1050	75	72.50	
1100	74	72	
1150	74	72	
1200	74	72	
1250	74	72	

calculate potential returns from stocker cattle programs. Then, after actual performance data of cattle used in these grazing trials were inserted incorporating the price structure contained in Table 9, an analysis of the comparative profitability of the different treatments was obtained. Included as part of the budget is a calculation of a breakeven purchase price for the cattle within breed x pasture groups. Table 10 illustrates the use of this budget as applied to the Angus cattle grazing endophyte-infected fescue.

The budget calculates profitability on a per head basis. Profitability on a per acre basis was determined using stocking rates stated in Chapter 1 and repeated in Table 11.

Table 10. Pasture budget for grazing cattle: Angus cattle on endophyte-infected fescue (OSU Pasture Budget).

		TOTAL COST	COST/DAY
Purchase Date	11/05/88		
Sale Date off Pasture	05/21/89		
Cattle Cost, $/cwt	95		
Purchase Weight, lbs	500		
Days Pastured	197		
Equity, $/head	-0-		
Cattle Interest Rate,%	12	31.39	0.16
Pasture Establishment	-0-	-0-	-0-
Pasture Maintenance	30.51	30.51	0.15
Medical Cost, $/head	8.00	8.00	0.04
Death Loss, %	1.00	4.91	0.02
Labor Cost, $/hd/day	0.05	9.85	0.05
Beef Check Off	1.00	1.00	0.01
Freight, $/head	8.00	8.00	0.04
Fixed Feed Costs, $/head	10.00	10.00	0.05
Implant costs, $/head	2.00	2.00	0.01
Operating Capital Interest, %	12	2.44	0.01
TOTAL		107.90	0.55
Daily Gain, lbs/day	1.15		
Cost of Gain, $/cwt	0.47		
Sale Weight, lbs	726		
Breakeven, $/cwt	79.94		
Sale Price, $/cwt	72.00		
Profit or (Loss), $/hd	(57.72)		
Brkvn. Pur. Pr., $/cwt*	83.46		

*Breakeven purchase price for stocker steers.

Developed by Donald Gill, Oklahoma State University

Table 11. Pasture stocking rates of cattle grazing endophyte-infected fescue (HE), endophyte infected fescue interseeded with clover (IS), and endophyte-free fescue (LE).

Treatment	Acres/Steer	Steers/Acre
HE	1.16	.86
IS	1.47	.68
LE	1.32	.76

PROFITABILITY COMPARISON OF TRIAL TREATMENTS

As expected, cattle of all breed combinations grazing endophyte-infected fescue gained significantly less than the other two treatments. The cattle grazing the interseeded fescue pastures had the highest average daily gain of the treatments followed closely by the cattle grazing the low-endophyte fescue. Table 12 contains a summary of the stocker budgets calculated for the cattle used in this trial.

Profitability followed performance within breeds of cattle for the different treatments. In general, across all breeds, cattle grazing interseeded clover pastures were the most profitable per head followed by low and then high endophyte pastures.

Pasture cost together with weight gain and marketability, were determinate factors for the profitability of cattle grazing the different treatments. Pasture establishment costs of $25.45 per head were charged against cattle grazing low endophyte fescue. This charge is a seven year payout on the establishment of low endophyte fescue. The cost of one year's deferred grazing is not included. Annual maintenance costs of $30.51, $37.49, and $40.26 per head were charged for high endophyte, interseeded clover, and low endophyte pastures, respectively.

In general, cattle grazing fescue pastures interseeded with clover were the most profitable per head and per acre followed by cattle of the same breed grazing low endophyte fescue. Cattle grazing endophyte-infected fescue were the least profitable. This can be attributed to the higher establishment and maintenance costs of low endophyte pastures and an increased stocking rate for high endophyte pastures. The lone exception was Brahman x Angus steers which were similar in profitability when grazing high endophyte fescue or low endophyte fescue. The reason, as pointed out in Chapter One, was that Brahman x Angus steers were not affected by the endophyte to the degree of Angus and Simmental x Brahman-Angus steers.

Angus and Simmental x Brahman-Angus steers suffered economic losses on high endophyte pastures. Brahman x Angus steers on infected fescue pastures however, had returns/acre that were comparable with Brahman x Angus cattle grazing low endophyte pastures.

The greater profitability of Brahman x Angus cattle compared to Angus or Simmental x Brahman-Angus on the high endophyte fescue may be attributed to a combination of factors. First, the Brahman breed character

Table 12. Comparative profitability of cattle grazing endophyte-infected fescue (HE), endophyte-infected fescue interseeded with clover (IS), or endophyte-free fescue pastures (November - May)

Item	HE	IS	LE
	ANGUS		
Purchase price, $/cwt	95	95	95
Ave. daily gain, lbs	1.15	1.92	1.82
Sale weight, lbs	726	879	858
Sale price, $/cwt[1]	72	78	79
Pasture costs, $/head/yr[2]			
Establishment	-0-	-0-	25.45
Maintenance	30.51	37.49	40.26
Breakeven, $/cwt	79.94	66.96	71.79
Profit or (loss), $/head	(57.72)	96.98	61.89
Profit or (loss), $/acre	(49.64)	65.94	46.89
Brkvn. Pur. Pr., $/cwt*	83.46	114.40	107.38
	BRAHMAN X ANGUS		
Purchase price, $/cwt	85	85	85
Ave. daily gain, lbs	1.73	2.33	2.08
Sale weight, lbs	841	958	910
Sale price, $/cwt[1]	74.50	73.50	74
Pasture costs, $/hd/yr[2]			
Establishment	-0-	-0-	25.45
Maintenance	30.51	37.49	40.26
Breakeven, $/cwt	62.68	55.71	61.84
Profit, $/head	99.37	170.63	110.67
Profit, $/acre	85.46	116.03	83.84
Brkvn. Pur. Pr., $/cwt*	104.87	119.13	107.13
	SIMMENTAL x BRAHMAN-ANGUS		
Purchase price, $/cwt	95	95	95
Ave. daily gain, lbs	1.42	1.92	1.80
Sale weight, lbs	779	878	855
Sale price, $/cwt[1]	70	78	79
Pasture cost, $/hd/yr[2]			
Establishment	-0-	-0-	25.45
Maintenance	30.51	37.49	40.26
Breakeven, $/cwt	74.49	66.96	72.12
Profit or (loss), $/head	(35.02)	96.98	58.78
Profit or (loss), $/acre	(30.11)	65.95	44.53
Brkvn. Pur. Pr., $/cwt*	88	114.40	106.76

*Breakeven purchase price for stocker steers.
[1]Sell price reflects differences in weight and any evidence of symptoms of fescue toxicosis.
[2]Pasture establishment and maintenance budgets contained in Chapter Two.

provides the animal with a greater heat tolerance, which may serve to compensate for an inability to regulate body temperature suffered by cattle grazing endophyte-infected fescue. This heat tolerance and possibly other breed-related factors allowed for greater pasture gains by the half-Brahman cattle.

Secondly, the basis differences under which these cattle were marketed benefited the Brahman cattle. The Angus and Simmental x Brahman-Angus steers grazed on endophyte-infected pastures sold for $23-25/cwt less than their $95/cwt purchase price. The severe symptoms of fescue toxicosis exhibited by these steers accounted for $9-10 of this discount. The basis problem was compounded by the reduced weight gain of the steers.

Brahman x Angus steers were not discounted for symptoms of fescue toxicosis although they did receive the usual discount for Brahman characteristics. These cattle were priced at $69/cwt, $16/cwt less than their $85/cwt purchase price. Also, the basis difference between Brahman and English or Exotic cattle narrowed with increasing weight.

Calculated breakeven purchase prices showed Angus and Simmental x Brahman-Angus cattle grazing endophyte-infected fescue to be worth $7 to $12/cwt less at the beginning of the trial than the $95/cwt used in the budget. Steers of all breeds grazing clover-fescue or low endophyte pastures had breakevens over $10/cwt higher than the price at which they were purchased.

PROFITABILITY COMPARISON OF TRIAL TREATMENTS

As expected, cattle grazing endophyte-infected fescue gained significantly less than the other two treatments. The low endophyte and interseeded clover cattle had similar gains. However, when profitability was calculated, a spread developed between the three treatments.

Although the cattle grazing low-endophyte fescue gained about as well as the interseeded clover cattle, the high input costs of nitrogen fertilization and the pasture establishment cost spread over seven years, reduced their net returns. Conversely, even though the stocking rate of the clover cattle was the least of the three treatments, good animal performance coupled with reduced pasture maintenance costs improved net returns.

CONCLUSION

At least three conclusions may be drawn given the previously stated observations. First, cattle on highly infected fescue pastures probably may not gain as well as cattle grazing renovated pastures. The endophyte toxins are quite effective in reducing animal performance and marketability. Gains on heavily infected pastures may be so poor as to severely restrict profitability.

If there is no choice but to use these existing infected pastures, Brahman cross cattle stand the greatest potential for a reasonable return to investments. In this trial, Brahman-Angus steers, across all treatments, were more profitable than the other breeds used. Brahman x Angus cattle were the only breed to show a profit when grazing endophyte-infected fescue. Further, the magnitude of the advantage for these cattle would probably be much greater if grazing is conducted later into the spring and summer (see Chapter One). At least half Brahman blood is recommended because the 1/4 blood cattle (S x BA) did not perform as well.

As emphasized several times in this chapter, the price basis for different breed types is critical for accurate evaluation of these grazing programs. Plans for retained ownership after grazing are critical because choice of a breed type can have a large impact on marketing flexibility.

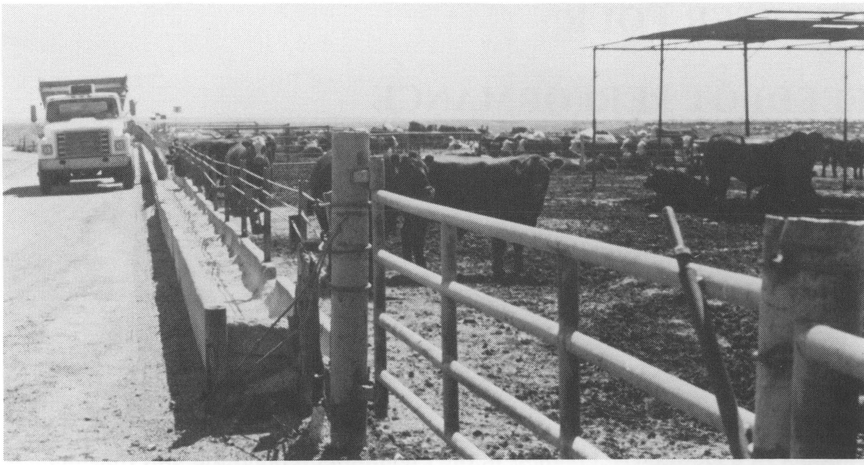
Lastly, if topographical, soil, moisture and financial conditions are not conducive to the renovation of high endophyte fescue pastures, the interseeding of clovers would be preferable to reestablishing to a fungus-free fescue variety. Currently, reestablishing costs are prohibitively high in these situations to match or exceed the returns offered by the interseeding with clover. There is currently some doubt as to the maintenance of a fungus-free fescue stand in a previously infected site. If, however, a new fescue pasture is desired in a site where endophyte-infected fescue has not previously grown, it is recommended that endophyte-free fescue seed be used.

CHAPTER FOUR

FEEDLOT PERFORMANCE OF STEERS GRAZED AS STOCKERS ON FESCUE

SUMMARY

Steers from the second and third year of the fescue grazing study were shipped to a commercial feedlot in the Oklahoma panhandle and finished. Steers had been grazed from November to May on: (1) Kentucky 31 fescue (76% endophyte-infected), (2) Kentucky 31 (74% infected) interseeded with a mixture of clovers, or (3) low endophyte Kentucky 31 fescue (0.7% infected). Steers were removed from fescue pastures in Eastern Oklahoma on May 21, held for 6 days on bermuda-ryegrass pastures and shipped 450 miles to a feedlot in Western Oklahoma. Steers were then fed for 117 or 113 days before slaughter. No treatment x year interactions were noted and data were pooled across years. Steers from high endophyte fescue pastures weighed 101 lb less than steers from low endophyte pastures at the end of grazing but high endophyte steers gained 68 lb more during the feedlot phase. High endophyte steers gained faster during the 6-day holding period, tended to lose less weight in transit to the feedlot, and gained faster during the first 48-49 days in the feedlot. Steers previously grazed on interseeded clover pastures gained similarly to low endophyte steers in the feedlot. Because of slightly greater gains on pasture and in the feedlot and greater gains during the 6-day holding period, interseeded clover steers had heavier slaughter and carcass weights than low endophyte steers. Rectal temperature was higher for high versus low endophyte steers at the end of fescue grazing and after the 6-day holding period. Temperatures of steers that grazed interseeded clover were intermediate. No difference in rectal temperatures were noted the morning following arrival at the feedlot. Carcass weights were lighter and quality grade tended to be lowest for high endophyte steers. This study showed that steers with clinical signs of fescue toxicosis can compensate for up to 67% of the reduced gains resulting from grazing infected fescue.



EXPERIMENTAL PROCEDURES

Steers from the second and third year of the fescue grazing study were shipped to the Henry C. Hitch Feedyard in the Oklahoma panhandle and finished. A total of 114 Angus, Brahman-Angus, and Simmental x Brahman-Angus were used. The steers were from 13 to 19 months old when placed on feed. Steers had been grazed from November to May on:

(1) Kentucky 31 fescue (76% endophyte-infected),

(2) Kentucky 31 (74% infected) interseeded with a mixture of clovers, or

(3) Low endophyte Kentucky 31 fescue (0.7 infected).

The grazing phase of the study was conducted at the Kerr Center, Inc. near Poteau in Eastern Oklahoma. The experimental procedure and results of the pasture phase of this study are described earlier in this publication (Chapter One).

Steers were removed from fescue pastures on May 21, 1987 (year 1) and May 19, 1988 (year 2), and hauled about 3 miles to a bermudagrass-ryegrass pasture adjacent to shipping facilities and held for 6 days before shipment. At the time of shipment, steers were weighed directly off the bermudagrass-ryegrass pasture at 5:00 p.m., loaded onto trucks, and shipped 450 miles during the night to the feedyard. The 6-day holding period on bermudagrass-ryegrass and night time shipping were used to minimize heat stress of steers from endophyte-infected pastures.

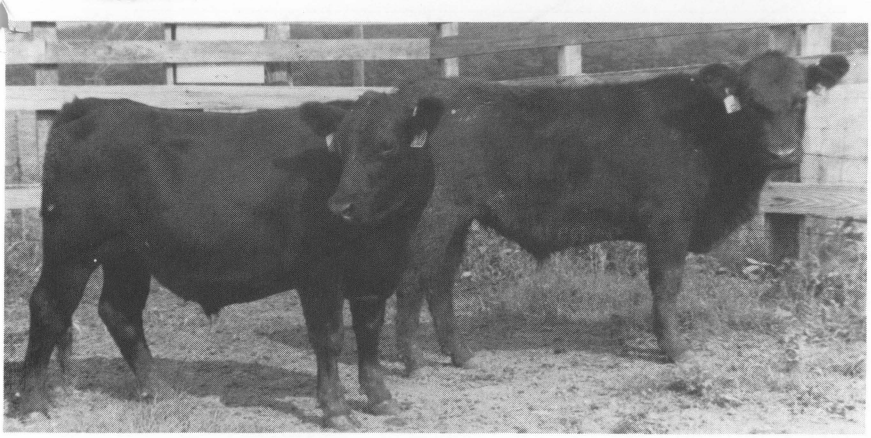
On arrival at the feedyard, steers were placed in their pen and rested until the following morning when they were individually weighed full on electronic scales, had rectal temperatures taken and were given routine processing procedures for incoming cattle. Processing consisted of IBR-BVD-Leptospirosis, BRSV, 7-way Clostidial, injections of Vitamin A and copper, implanting with Synovex-S and deworming with ivermectin.

Steers were then fed for 117 days in year 1 and 113 days in year 2 on a 90% concentrate finishing ration with high moisture corn, steam flaked corn and steam flaked wheat. The ration contained approximately .97 Mcal/lb NEm, .62 Mcal/lb NEg and 12.65% CP on a dry matter basis. All steers were slaughtered at a commercial packing facility about 50 miles from the feedyard.

Steers weights at the end of the fescue grazing phase were taken after overnight withdrawal from feed and water. All other weights were full. Steers were weighed individually at about 49 days into the feeding period, and again the day before slaughter. Steers were slaughtered on September 22, 1987 and September 15, 1988. Steers were graded about 24 hours after slaughter. Calculations of weight gain to the approximate mid-point of finishing and to final live weight before slaughter were based on 4% pencil shrinks (actual full weights multiplied by .96) for mid-period and final live weights.

RESULTS AND DISCUSSION

For detailed results of the pasture phase of this study, the reader should review Chapter One of this publication. At the end of approximately 197



The steer on the left grazed endophyte-free fescue while the steer on the right came from endophyte-infected pastures. Note the difference in the haircoat, fleshing, and fill.

days of fescue grazing in late May, high endophyte steers showed typical clinical signs of fescue toxicosis including reduced gains compared to low endophyte steers (101 lb), rough hair coats and elevated rectal temperatures. Steers grazing interseeded clover had slight signs of fescue toxicosis, but weight gains were similar to low endophyte steers.

Unlike the situation in the grazing phase of the study, no breed x pasture treatment interaction was seen with the feedlot data. During the pasture phase, Brahman-Angus steers had less depression in weight gains than Angus or Simmental x Brahman-Angus steers when grazing endophyte-infected fescue. In the feedlot, however, all three breeds from endophyte-infected pastures gained faster than steers previously grazed on endophyte-free pastures. Because there was no breed x treatment interaction, feedlot performance is not shown for each breed within each pasture treatment.

During the 6-day period when cattle were held on bermudagrass-ryegrass pasture close to the shipping facility, steers previously grazing high endophyte and interseeded clover pastures gained faster (Table 13) than those

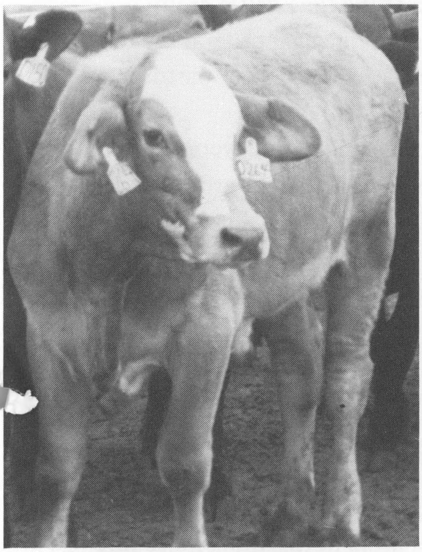
Table 13. Weight gains and body temperatures through the finishing period of steers that had grazed fescue pastures.[a]

	Treatments		
	Endophyte Infected Fescue	Infected Fescue & Clover	Endophyte Free Fescue
No. Steers	41	34	39
Weight off fescue pasture, lb	768^{c}	878^{b}	869^{b}
Weight changes, lb			
6-day holding period	35^{b}	44^{b}	22^{c}
Transit to feedlot	-22	-33	-35
Weight gains in feedlot, lb			
First 48-49 days on feed	222	200	196
July to finish, 65-68 days	231	227	218
Off fescue to slaughter	466^{c}	$440b^{c}$	400^{b}
Total, pasture plus feedlot, 315-319 days	713^{a}	792^{c}	748^{b}
Final finish weight, lb	1236^{b}	1313^{d}	1269^{c}
Rectal temperature, F			
At time of shipping[e]	103.4^{c}	103.1^{c}	102.8^{b}
At processing feedlot	102.2	102.0	101.8
In feedlot, July	104.1	103.9	104.0

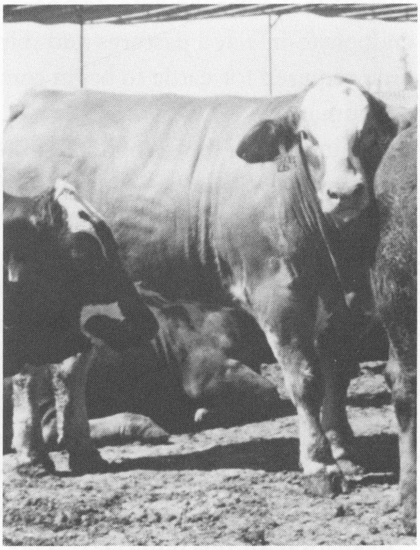
[a]Two years data
[bcd]Means on the same line with different superscripts differ (P<.05)
[e]Second year only

previously on low endophyte pastures (35 and 44 vs 22 lb). Because the shipping weight was taken without shrink, results suggest that high endophyte steers took on more fill and/or began gaining more rapidly than low endophyte steers when offered non-endophyte infected forage. In other studies, reduced forage intake has been shown to be a major factor in poor performance of cattle grazing endophyte-infected fescue.

In the present study, high endophyte steers appeared gaunt at the end of the grazing study and heavy forage accumulation in the endophyte infected pastures suggested reduced intake of endophyte-infected fescue. The rapid gains of interseeded clover steers during the 6-day holding period was unexpected because of the similar pasture gains on interseeded clover and low endophyte steers during the fescue grazing period. Weight losses during transit to the feedlot were similar for all three groups.



This crossbred steer gained only 1.02 lbs/day while grazing endophyte-infected fescue from November to May. He weighted 800 lbs at the end of grazing.



This is the same steer pictured at left at the end of 117 days of finishing. His final weight was 1464 lbs (after 4% pencil shrink) and his average daily feedlot gain was 5.67 lbs/day.

FEEDLOT GAIN

During the first 48-49 days on feed, steers from high endophyte pastures gained 222 lb compared to 200 lb for interseeded clover and 196 lb for low endophyte steers. The increased rate of gain during the first part of the finishing period, together with more rapid gain during the 6-day holding period suggests that effects of the endophyte in this study were not permanent and that compensatory gain and/or fill began almost immediately after removal from the infected fescue. These results agree with research in which steers that had grazed fescue in Georgia were shipped to Texas for finishing during summer and early fall. In the Georgia-Texas studies, cattle that had grazed high endophyte fescue made more rapid gains, especially during the first 28 days in the feedlot.

In Arkansas trials, steers were moved from fescue pastures to feedlot pens in Arkansas. Steers previously grazing endophyte-infected pastures made greater gains than steers from endophyte-free pastures when steers were moved to the feedlot in October but not in July. These studies strongly suggest that environmental temperature at the time cattle are removed from endophyte-infected pastures and shipped to finishing programs can affect the time required for cattle to begin compensating for poorer pasture performance.

Gains during the second half of the finishing period were similar for all three groups, suggesting that most of the compensatory growth occurred relatively early in the feeding period. This is the typical pattern for compensatory gain. Total weight gains from the time of removal from fescue grazing to slaughter were significantly greater for high endophyte (466 lb) compared to low endophyte steers (400 lb) with interseeded clover intermediate (440 lb).

A slight advantage in weigh gain for interseeded clover steers compared to low endophyte steers in every phase of the study resulted in a significantly increased total gain from the onset of fescue grazing to slaughter (792 vs 748 lb), and a greater final finish weight (1313 vs 1269 lb). Although an explanation for this difference is not apparent at this time, these findings are both interesting and consistent.

BODY TEMPERATURE

Rectal temperatures at the time of removal from fescue were significantly affected by pasture treatments. Following the 6-day holding period, temperatures were still higher for high endophyte steers than for low endophyte steers (103.4 vs 102.8 F) with interseeded clover intermediate (103.1 F). The rectal temperature of one high endophyte steer (Simmental x Brahman-Angus) was 107.3 F at the time of removal from pasture. This steer exhibited extreme distress and was not shipped to the feedlot because it was felt he would not survive the stress of transportation. Heat stress is the major risk factor in handling cattle from high endophyte fescue.

Rectal temperatures at 48-49 days on feed were again similar for steers on all treatments (Table 13). All temperatures were higher than "normal" for cattle but were probably not atypical for steers on a full feed of a high concentrate diet. One steer each year died in the feedlot. However, neither death was believed related to previous pasture treatment nor was the steer from the high endophyte treatment. Sickness was minimal throughout the study.

CARCASS CHARACTERISTICS

Carcass characteristics are shown in Table 14. Carcass weights reflected live weights and were significantly lighter for high endophyte steers compared to low endophyte and interseeded clover steers (794 vs 821 and 849 lb). Fat thickness and yield grades were similar for steers on all treatments. high endophyte steers tended to have lower quality grades and smaller ribeye

Table 14. Carcass characteristics of steers previously grazed on fescue pastures.[a]

	Treatments		
	Endophyte-Infected Fescue	Infected Fescue & Clover	Endophyte-Free Fescue
Slaughter			
KHP[b], %	2.2	2.1	2.2
Quality grade[c]	10.8	11.4	11.2
Hot carcass weight, lb	794[d]	849[f]	821[e]
Ribeye area, sq in^2	13.1	13.6	13.6
Fat thickness, in	.45	.47	.46
USDA Yield Grade	2.86	2.95	2.85
Dressing percent	64.2	64.7	64.7
USDA Quality Grade, %			
standard	15	--	--
select	60	50	60
choice	25	50	40

[a]Two years data
[b]Kidney, heart and pelvic fat
[c]11=Select+, 12=Choice-, etc.
[def]Means on a line with different superscript letters differ (P<.05)

areas than the others. The percent of steers in each quality grade showed that all standard carcasses were from the high endophyte treatment. High endophyte steers also had the fewest choice carcasses. The lower grades of the high endophyte steers probably reflect their light weights and poorer body condition going on feed. Cattle in this study were slaughtered after equal days of feeding. Had the high endophyte steers been fed slightly longer and to carcass weights closer to low endophyte steers, the difference in carcass grade may have disappeared.

Although feedlot performance is not shown for each bred within each pasture treatment, most producers are very interested in performance of different breeds. In order to provide this information, gain and carcass data are shown in Table 15 for the three breeds used in these studies. While it would have been very tempting to break out feedlot performance by each breed and pasture treatment combinations, the absence of feed intake data (and therefore, feed efficiency) for individual groups would require far too

Table 15. Feedlot weight gains and carcass characteristics of Angus, Brahman-Angus and Simmental x Brahman-Angus steers.

	Breed		
	Angus	Brahman x Angus	Simmental x Brahman-Angus
Weight			
Off fescue pasture, lb	824[b]	920[e]	813[d]
Weight changes, lb			
6-day holding period	46[d]	18[e]	40[d]
Transit to feedlot	-35	-33	-31
First 48-49 on feed	218	198	198
July to finish	244[d]	197[e]	236[d]
Total gain			
Off fescue to slaughter	474[d]	381[e]	442[d]
pasture plus feedlot	774[d]	778[d]	732[e]
Final finish weight	1297[d]	1301[d]	1255[e]
Hot carcass weight, lb	824[e]	853[f]	800[d]
Ribeye area, sq in	13.5[d]	12.8[e]	13.9[d]
USDA yield grade	3.1[d]	3.2[d]	2.3[e]
Dressing, %	63.5[d]	65.5[e]	63.8[d]
USDA, quality grade[1b]	11.9[d]	11.2[d]	10.2[e]
Fat thickness, in	.55[d]	.46[e]	.35[f]

[a] Two years data.
[b] 11=select , 12=choice¯, etc.
[def] Means on a line with different superscript letters differ (P<.05).

many assumptions. However, by presenting averages for both pasture treatment and breeds, the reader may estimate feedlot performance for different breeds following fescue grazing based on his experience and the advise of others skilled in cattle feeding.

Brahman-Angus steers were the heaviest at the end of fescue grazing. During the 6-day holding period, Brahman-Angus steers gained and/or filled less than the Angus and Simmental x Brahman-Angus steers. Because the Brahman-Angus steers had the best gains during fescue grazing, especially on infected fescue pastures, it would not be surprising that they would show less gain and/or fill after removal from fescue. Shrinks during transit to the feedlot were almost identical for all three breeds.

In the feedlot (Table 15) the highest gains were made by Angus and Simmental x Brahman-Angus steers and the lowest gains by Brahman-Angus. There may be two reasons for this. First, the greatest advantage for cattle with high percentages of Brahman breeding is seen when grazing low to medium quality roughages, and the least advantage is seen with finishing rations. Second, the Brahman-Angus steers had the best gains during the grazing phase and were, therefore, significantly heavier at the start of finishing than the other two breed groups. It is unfortunate that feed efficiency data could not be collected during the finishing phase of these studies. Because of their excellent feedlot performance, Angus steers had total weight gains (pasture and feedlot) about equal to total gains of Brahman-Angus steers. Somewhat surprising, total pasture and feedlot gains for Simmental x Brahman-Angus steers were the lowest.

Carcass weights were heaviest for Brahman-Angus steers followed by Angus and Simmental x Brahman-Angus steers. Dressing percent was highest for the Brahman-Angus. As measured by fat thickness over the 12th rib, Angus steers were the fattest and Simmental x Brahman-Angus the leanest. Angus carcasses graded about low choice, Brahman-Angus averaged a grade of select, while Simmental x Brahman-Angus averaged standard grade. Based on the backfat thickness of each breed, the Angus steers in this study were probably fed too long while the Simmental x Brahman-Angus steers should have been fed more days.

CONCLUSION

Steers previously grazing high endophyte pastures weighed 101 lb less than steers from low endophyte pastures at the end of fescue grazing. There was compensatory gain following removal from high-endophyte pastures and continuing through the first 48-49 days of the finishing period. By the end of the feedlot phase, high endophyte steers weighed only 33 lbs less than low endophyte steers. Interseeding clover appears to be an effective means of partially offsetting the undesirable effects of the fescue endophyte. Steers from interseeded clover pastures gained slightly faster than low endophyte fescue steers both during grazing and in the feedlot, and were significantly heavier than low endophyte or high endophyte steers at the time of slaughter. If heat stress can be minimized during shipment to the feedlot and during the first few weeks of finishing, cattle previously exposed to fescue endophyte can perform very well in the feedlot and can compensate for much of the reduced performance during grazing.

CHAPTER FIVE

THE ECONOMICS OF FEEDLOT CATTLE PREVIOUSLY GRAZING ENDOPHYTE-INFECTED FESCUE, ENDOPHYTE-INFECTED FESCUE INTERSEEDED WITH CLOVER, OR ENDOPHYTE-FREE FESCUE

INTRODUCTION

As evidenced by this and other trials, cattle exhibiting symptoms of fescue toxicosis have the ability to compensate in the feedlot for reduced gains suffered during grazing. Their performance and profitability during this production phase is dependent on the handling and care they receive upon removal from the pasture. Marketing, transportation, and feedlot receiving conditions must be such that stress is minimal (see Chapter Six).

Determination of the comparative profitability of feedlot cattle previously grazing different fescue pastures was accomplished with the use of a computer budget (see Table 16). When actual performance data of the trial cattle are input into the program, accurate analyses of profitability are calculated.

Feedlot in-weights are averages of the unshrunk shipping weights of each treatment minus three percent. It was decided that shipping weights taken after the 6-day holding period on bermuda-ryegrass pasture provided the most logical starting point for calculation of post-grazing performance. It would not have been practical to ship the steers directly to the feedlot after the final fescue weights because these weights were taken after overnight withdrawal from grass and water. While this procedure gives accurate research data on pasture gains, it would not simulate actual sale or shipment conditions. The research reported in this publication clearly shows that cattle grazed on endophyte-infected fescue will make significant gains during a short period on non-fescue forage. Therefore, using a 3% pencil shrink of the full weight after 6 days on bermuda-ryegrass pasture offers a practical compromise for the seller who desires more sale weight and the buyer who desires minimum health risk. Readers may use gain data in Chapter Four to adjust sale/purchase weights to fit different situations.

As previously stated, it was not possible to feed each pasture treatment separately in the feedlot to obtain feed intake data. However, feed intake is

Table 16. Feedlot budget: Steers formerly grazing endophyte-infected fescue.

Cattle cost, $/cwt	72.16		
Purchase weight, lbs	782		
Days on feed	115		
Feed cost/ton (as-is)	105.00		
Ration dry matter, %	70		
Feed cost/ton (dry)	150.00		
Selling price, $/cwt	73.33		
		TOTAL COST	COST/DAY
Equity, $/head	-0-		
Cattle interest rate, %	12	21.63	0.19
Death loss, %q	.75	4.28	0.04
Medical cost, $/head	7.00	7.00	0.06
Yardage cost, $/hd/day	.05	5.75	0.05
Daily Feed (D.M.), lbs	25		
Daily gain, lbs/hd/day	3.95		
Operating interest, %	12	4.38	0.04
NON-FEED TOTAL		43.04	0.37
FEED COST/HEAD		215.63	1.88
TOTAL COST/HEAD		258.67	2.25

Daily gain, lbs/hd/day	3.95
Feed/gain, lbs	6.33
Cost of gain fdlt, $/cwt	50.28
Cost of gain totl, $/cwt	56.94
Selling weight, lbs	1236.25
Total dollars Ret'd, $/hd	906.54
Total less cattle cost, $/hd	342.25
Brkvn selling price, $/cwt	66.57
Profit or loss, $/head	83.58
Brkvn purchase price, $/cwt	82.85

Filename, FLCALC (Developed by Donald Gill, Oklahoma State University, 1984).

obviously critical to any accurate economic analysis. Based on research at other locations, estimated feed intake for steers from high endophyte pastures was set at 1.5 lb more dry matter than clover or low endophyte groups.

Pay-weights are final weight minus four percent. The steers were priced into the feedlot at the average price for each breed, with allowances for weight and any symptoms of fescue toxicosis, minus three percent. Therefore, the set in price for these steers reflected the numbers of each breed type used in the trials, approximately 33% Angus, 33% Brahman-Angus and 33% Simmental x Brahman-Angus. Selling prices at slaughter were determined using the price structure contained in Table 9, in which half Brahman cattle receive a $2/cwt discount at finish weight. Ration costs were figured at $150/ton on a dry matter basis.

FEEDLOT PROFITABILITY

Steers previously grazed on endophyte-infected fescue yielded a profit of $83.58/head compared with $24.39/head and $17.19/head for the clover and endophyte-free cattle, respectively (Table 17). When the value of these cattle is expressed in terms of a breakeven purchase price, the cattle suffering form fescue toxicosis were worth $82.85/cwt, over $10/cwt more than the $72.16/cwt at which they were set in. The other two groups of cattle, interseeded clover and endophyte-free, had breakeven purchase prices of $79.20 and $70.30/cwt, respectively, about $3/cwt over their set-in price.

Table 17. An economic comparison of feedlot cattle previously grazing endophyte-infected fescue (HE), endophyte-infected fescue interseeded with clover (IS), or endophyte-free fescue (LE).

Item	Endophyte Infected Fescue	Infected Fescue Clover	Low Endophyte Fescue
In weight, lbs	782	905	874
Set-in price, $/cwt	72.16	76.50	77.33
Pay weight, lbs	1236	1320	1286
Dry matter intake, lb	25.0	23.5	23.5
Average daily gain, lbs	3.95	3.61	3.59
Estimated feed/gain, lbs	6.33	6.51	6.55
Breakeven, $/cwt	66.57	71.48	71.99
Average sell price, $/cwt	73.33	73.33	73.33
Profit, $/head	83.58	24.39	17.19
Brkvn. pur. pr., $/cwt	82.58	79.20	79.30

This advantage was due largely to the increased rate of gain of steers from endophyte-infected pastures and the narrowing of the basis difference in price when the symptoms of fescue toxicosis in the Angus and Simmental x Brahman-Angus disappear during finishing.

The average return for the high endophyte steers would be significantly higher if the returns were calculated on the Angus and Simmental x Brahman-Angus steers only. These cattle, the most negatively affected by the endophyte toxin, offered the greatest financial return to feeding within this treatment group. The Brahman-Angus cattle, apparently not as significantly affected by the toxin, performed only as well as the Brahman-Angus cattle in the other pasture treatments and they demonstrated no compensatory gain. Also contributing to the profitability of the Angus and Simmental x Brahman-Angus cattle is the reduced price per hundred at which they were set into the feedlot. This lowered price is a reflection of market bias against cattle exhibiting symptoms of fescue toxicosis. But upon finishing, these steers sold comparatively to cattle having never exhibited these same symptoms.

While it would be tempting to calculate returns for each breed within each previous pasture treatment, the lack of feed intake data for each group would make these calculations very suspect. As a result, calculations for breeds within treatment are not made. As stated in the previous chapter, readers may take breed performance presented in Table 15 and modify economic estimations presented here to the degree that they feel confident doing so.

As illustrated in Table 14, endophyte-infected cattle yielded a lower percentage of Choice grade carcasses. This would have a significant effect upon profitability. The cattle in this trial were fed a set number of days. Had the possibility existed, the endophyte-infected cattle could have been fed for a longer period of time to correct for the lower overall quality grade of the carcasses.

SUMMARY

The combination of potentially reduced price as feeders and excellent gains in the feedlot make cattle showing signs of fescue toxicosis good candidates for retained ownership into the feedlot. If adequate precautions can be taken to minimize health risks during transit to the feedyard, these cattle should command a premium as feeders rather than a discount.

Considering both pasture and feedlot phases, overall profitability favored steers grazed on interseeded clover pasture and carried through the feedlot. While cattle previously grazed on infected fescue yielded the greatest comparative returns in the feedlot, they did not completely overcome their poor performance during grazing.

CHAPTER SIX

RECOMMENDATIONS FOR SHIPPING AND RECEIVING CATTLE SHOWING SYMPTOMS OF FESCUE TOXICOSIS

Although field reports exist of cattle being so damaged from fescue toxicosis during grazing that performance during the finishing phase is severely depressed, the majority of research trials show that cattle can be expected to compensate for some of the performance lost during grazing. Depending on circumstances (cattle type, time of year, temperature, etc.), the degree of compensatory gain can be slight to as much as .6 lb/day during finishing. If the potential for death loss and morbidity during the first 2 or 3 weeks of shipment can be avoided, cattle from infected fescue pastures should perform at least as well as heavier, better fleshed counterparts from uninfected pastures.

This should not be interpreted to mean that buying or feeding severely affected cattle is without risks. It is well documented that these cattle cannot control their body temperature. Reports of high death losses when severely affected cattle were shipped during hot weather and suffered heat stress are all too accurate.

Following are guidelines which may serve to minimize the stress of handling cattle which exhibit fescue toxicosis:

1. Make every effort to avoid heat stress. Gather cattle during cooler morning or evening hours. Allow easy access to clean water. Do not excite the cattle.

2. If possible, do not gather and ship the cattle on the same day unless it is possible without undue movement and stress. Move the cattle close to the shipping facilities a few days before shipment and feed non-toxic forage or other feed during this period.

3. During hot weather, truck the cattle overnight. This permits loading during cooler evening hours and unloading at the feedlot during early morning the following day.

4. Notify the feedlot manager that he is about to receive fescue affected cattle. He should rest the cattle a day or two after arrival and process early in the morning the second or third day. He should ignore body temperature as an indicator of respiratory disease. Some managers will also be prepared

to spray water on the cattle if they appear to be heat stressed.

5. It may be logical to seek a cool, dry climate for feeding, although eastern feedlots have been successful in handling fescue cattle.

6. If buying affected cattle from salebarns, the situation will be a bit trickier because of a lack of control over shipping and salebarn conditions. Producers should be very careful of cattle that already show signs of elevated body temperature (panting, high respiration rate, excitability). Unless means, such as sprinklers, are available to cool these cattle the stress of waiting an additional 2 or 3 hours in a hot salebarn for loading on trucks may present a high potential for death loss.

CHAPTER SEVEN

OTHER MEASURES TO MINIMIZE THE INCIDENCES OF FESCUE TOXICOSIS

This publication is a result of work performed by Oklahoma State University personnel with cattle grazing fungus-infected fescue. The results demonstrate significant improvement in animal performance and profitability when clovers are interseeded into this fescue. The purpose of this section is to recognize other practices which may serve to lessen the incidence or effect of fescue toxicosis in cattle grazing infected fescue.

OVERSEEDING WITH NON-LEGUMES

The advantages gained from interseeding clover into fungus-infected fescue are reflected in improved animal performance and profitability. These results are not due to increased forage production but rather from a decreased intake of the fungus toxins by grazing cattle. This is accomplished by increasing the proportion of the animal's diet that is not fungus-infected fescue. Because soil pH and other factors make legumes impractical in some situations, other cool-season forages are a possible alternative.

Efforts to increase forage production and stocking rates utilizing cool-season annuals will probably not serve as a viable alternative to clovers. Interseeding annual ryegrass, wheat, oats, or rye into fungus-infected pastures and following with nitrogen fertilization will largely be ineffective due to the extreme competition offered by the established tall fescue.

In order for the winter annual to produce any appreciable quantity of forage, an application of nitrogen would certainly be needed. The tall fescue would use most of this nitrogen because, being already established, it could quickly out-compete the annual. For this practice to have any productivity, either an application of Gramoxone Super prior to, or at planting, would be needed. A thorough discing could be used to "setback" the tall fescue. In either event, the additional costs of the practice would probably render it uneconomical.

CONSIDERATIONS FOR GRAZING FUNGUS-INFECTED TALL FESCUE PASTURES

The concentration of the fescue endophyte within the plant decreases in the order: seedhead > stem (seed stalk) > leaf sheath > leaf blade. By planning a grazing program so that livestock only have access to immature plants, some of the negative effects may be alleviated. Avoid grazing mature plants in late spring and avoid grazing during hot weather. Mow old seedstems off prior to fall grazing.

Stockpiling tall fescue forage (letting fescue grow during the fall) has been a common practice for many years. This stockpiled "reserve" can be a very economical way to winter mature cattle although lighter weight cattle and calves nursing cows may have reduced weight gains on stockpiled tall fescue. Stockpiled fescue from endophyte infected pastures should be used with caution. If the forage contains the endophyte, there is the possibility of reduced gains and also of "fescue foot" if cattle graze accumulated mature forage from highly infected pastures during cold weather. Management can minimize the risks from stockpiling fescue. Supplemental feeding of grain, non-fescue hay, or pasture rotation to non-fescue pastures will have the effect of diluting the intake of the fescue endophyte and thereby lessen the problems.

Tall fescue hay that is baled from endophyte-infected pastures will remain as infected as the pasture from which it came. This hay should never be fed to animals that are grazing only infected pastures. Infected hay should be fed to animals grazing non-infected pastures such as dormant native grasses or bermudagrass. Non-fescue hay or endophyte -free fescue hay should be fed to animals grazing infected pastures, especially stockpiled pastures. Dilution is important to reducing the effects of toxic fescue.

PLANT GROWTH REGULATORS (PGR's)

Plant growth regulators have been shown to delay the maturity of tall fescue if applied in the spring. One such plant growth regulator, mefluidide (tradename Embark), suppresses seed head development and maintains vegetative growth longer into late spring and early summer. By delaying maturity, the nutritional quality may be extended during the summer grazing period.

Since the endophyte produces toxins which tend to concentrate in the maturing seedstems and seeds, any method of reducing seedstem production would tend to lower toxin concentration. Work in Missouri has shown that mefluidide, or Embark, does increase nutritional quality of tall fescue in late spring and early summer. However, by mid-summer, even animals on mefluidide-treated tall fescue were showing symptoms of fescue toxicity.

Mefluidide does not have any effect on the degree of infection of the plant. At the present time Embark is not labeled by the Environmental Protection Agency (EPA) for use in pasture situations.

GRAIN SUPPLEMENTATION

As mentioned previously, a key factor in enhancing performance of cattle grazing endophyte-infected fescue pastures is the dilution or elimination of fescue toxins in the diet. Although good data are scarce, grain supplementation may improve the performance of cattle grazing infected pastures.

In a research trial conducted by Missouri workers, non-implanted and implanted stocker cattle grazing fungus-infected fescue were supplemented with two (2) pounds of corn/head/day. Those cattle receiving the supplement showed improvements in average daily gains of .39 and .31 lbs/head/day, respectively. Feed conversion calculates to approximately 5.1-6.4 lbs of feed/lb of additional gain. These cattle were grazed from May to September, a time when the effects of fescue toxicosis would be maximal and fescue quality would be at its lowest. No mention of the visible symptoms of fescue toxicosis were made.

Based on observed gain responses of steers grazing clover pastures compared to fescue alone, the best times to supplement grain on infected pastures is probably from mid-march to the end of grazing in late spring or early summer. Although an exact level of grain is not known, a daily rate of under four pounds might be a starting point.

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