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# TALL FESCUE PASTURE MANAGEMENT SYSTEMS FOR BEEF COWS

A Dissertation

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## ABSTRACT

Tall fescue (Festuca arundinacea Schreb.) is the most important pasture grass used as a base for beef pastures in the upper mid-South because of its ease of establishment, hardiness, and response to nitrogen fertilizer and (or) renovation with legumes. However, in spite of its excellent agronomic characteristics, tall fescue has been criticized throughout its region due to poor performance of the animals consuming this forage. Several researchers have discussed management practices which can be used to improve animal performance and increase the amount of beef produced per acre.

Eight 10-acre pastures, stocked with approximately 5 cow-calf units (.5 units per acre), were used in this study to: (1) compare fescue cultivars (Kentucky 31 and Kenwell), (2) study the effects of renovation and nitrogen fertilization on animal performance and pasture productivity, (3) compare renovation methods, and (4) compare extensive and intensive pasture management.

Kentucky 31 and Kenwell cultivars supported similar animal gains; renovation of tall fescue pastures with legumes in the early spring increased animal gains; cow and calf condition scores were higher for renovated pastures; spring fertilization of fescue sod with nitrogen reduced calving percentage; the addition of nitrogen fertilizer to tall fescue pastures during the spring reduced individual cow and calf gains; feed production was greater from pastures nitrated in the spring and fall; total beef produced per acre

was greater on nitrated pastures. The best combination of management practices to increase fall feed production and spring-summer forage quality were fall nitrogen fertilization (75 pounds per acre) followed by spring renovation with ladino clover and lespedeza.

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# CHAPTER I

## INTRODUCTION

Tall fescue (Festuca arundinacea Schreb.) is the most dynamic and versatile pasture grass available to the beef cattle producer in the transition region of the United States. It is grown on an estimated 35 million acres and is adapted to a wide range of soils. Due to its ease of establishment and hardiness in adverse climatic conditions and under intense grazing, tall tescue has become a favorite grass of livestock producers in the upper Mid-South. It responds well to nitrogen fertilization and (or) renovation with legumes. In Tennessee, tall fescue has become increasingly popular over the past thirty years. Presently, there are over 3,500,000 acres of fescue pasture in this state, and it is equally important in adjacent states.

During the past thirty years, expanded livestock production in the transition zone of the United States would not have been accomplished as easily without the use of tall fescue. The least-cost approach to permanent pastures for future increases in livestock production in this area will continue to depend on increased production of tall fescue and increased livestock performance from tall fescue based pastures. In spite of its excellent agronomic characteristics and forage quality, tall fescue has been criticized throughout the region because of low performance of animals consuming this forage. Researchers have noted that cattle grazing tall fescue pastures had low weight

gains, rough hair coats, did not shed their winter coats until later than the usual times, and exhibited a generally unthrifty condition. Also animals grazing fescue may have body temperatures 2°F higher than normal, salivate excessively, and show excessive nervousness. High ambient temperatures tend to intensify these anomalous conditions called "fescue toxicity" or "summer syndrome." Other researchers have reported a sloughing of the tail, lameness in the rear legs, and fat necrosis in the abdominal cavity.

Several researchers have found high correlations of incidence of an endophytic fungus, Acremonium coenophialum (Morgan-Jones and Gams) found in the leaves and stems of tall fescue, with the incidence of aforementioned symptoms. The development of a fungus-free strain may further enhance the value of fescue as a basic pasture grass. Other researchers have reported that the incorporation of legumes into the fescue sod causes these symptoms to be less severe.

The purpose of this study was (1) to present data, collected over the past sixteen years, regarding fescue pasture management systems which may affect the quality of fescue forage and (2) to suggest one or more systems that have application to the Tennessee beef cattle industry.

# CHAPTER II

# REVIEW OF LITERATURE

## I. HISTORY AND ORIGIN OF TALL FESCUE

Tall fescue (Festura arundinacea Schreb.) was introduced into the United States from Western Europe (Siegel, 1983). Although the exact time of its introduction is not known, its importance as an agronomic crop was not recognized until the early 1940's with the release of the Kentucky 31 and Alta cultivars by the Kentucky and Oregon Agricultural Experiment Stations, respectively (Buckner et al., 1979).

In 1931, an agronomic event occurred in Kentucky that was of much importance to agriculture, not only in Kentucky but other states and nations as well. That was the discovery, by Dr. E. N. Fergus, of Kentucky 31 tall fescue (as it was later named) growing on a farm in Menifee County in eastern Kentucky. Dr. Fergus was on a farm in Menifee County judging sorghum syrup at a local show when he was approached by one of the natives who asked if he was aware of a good grass that was growing in the county. Dr. Fergus indicated he was not aware of the grass and he was taken to the hill farm of W. M. Suiter to observe this "wonder grass." Arriving at the farm, Dr. Fergus observed several fields of this grass. One large hillside was covered with it. It was opposing soil erosion and livestock were grazing it. Although the weather had been cold, the grass was still green. Dr. Fergus

obtained about a pound of seed of this fescue from Mr. Suiter and seeded it on the University of Kentucky Experiment Station in 1932. The long life of the grass and its ability to persist was evident from seedings made throughout the state. It was noted also to be unusually deep-rooted for a cool season grass. Dr. Fergus had no doubts about the plant's climatic adaptation since it had been growing in Menifee County for many years (Lacefield et al., 1983).

According to Lacefield et al. (1983), a patch of the grass was probably on the farm when Mr. Suiter purchased it in 1887. The seed for the original planting on the farm presumably came from a seedsman in Virginia. When recognized as a variety of tall fescue, it was designated Kentucky 31 due to the fact that it was originally identified in 1931. From 1932 to 1939 seedings were made in outlying experimental fields and in 1939 seed was distributed by W. C. Johnstone for trials by interested farmers. After testing, this grass was released in 1942 as the Kentucky 31 cultivar. In 1945 it was included in the Kentucky seed certification program and was readily accepted by Kentucky farmers and subsequently vast acreages have been seeded (Lacefield et al., 1983).

Tall fescue is now the predominant cool season grass species grown in the transition zone between the latitudes of Indianapolis, Indiana, and Macon, Georgia, and between the meridians of eastern Kansas and the eastern edge of the Piedmont area (Burns and Chamblee, 1979). Tall fescue is presently being grown on approximately

35 million acres in the United States in pure or mixed stands (Buckner, 1979).

## II. CHARACTERISTICS OF TALL FESCUE

Tall fescue grows well on soils ranging in pH from 4.7 to 9.5. It thrives on thin soiled, droughty slopes, yet it makes a dense sod and produces excellent growth on poorly drained boggy soils where few other cool season grasses survive (Cowan, 1956). Hafenrichter et al. (1949) found that adaptability and productivity of tall fescue depended on at least 18 inches of rainfall per year and elevations below 5,000 feet. However, Bailey (1952) suggested that tall fescue should not be recommended in southeastern areas which receive less than 36 inches of rainfall per year or for sandy soils having long periods of drought. The adaptability of tall fescue to a wide range of soils and climate, its coarse, deep root system, its ability to grow on low-lying sites with moist, heavy soils, and its ability to withstand waterlogging and flooding makes the cultivar particularly valuable for conservation purposes. Millions of acres that were severely eroded due to continuous cultivation have been "healed" and restored to lush, green, productive pastures by the establishment of tall fescue (Buckner et al., 1979). Although tall fescue responds well to nitrogen fertilization for both spring growth and fall stockpiling, this practice significantly reduces the soluble carbohydrate content of both winter and summer growth. Nitrogen fertilization has been shown also to increase the alkaloid (perloline) level in the grass. Other data show

that alkaloid levels may be affected by management practices; for example, higher perloline content was observed under grazing conditions than when fescue was harvested as a hay crop (Wilkinson and Mays, 1979).

Tall fescue grows well at 40°F and is not completely dormant until temperatures fall below 34°F (Leasure, 1952). Most cool season grasses exhibit reduced growth above 77°F. When soil moisture is adequate, tall fescue remains green and continues some growth at this temperature level. However, stand thinning does occur if moisture stress becomes severe (Chamblee, 1960).

## III. FORAGE PRODUCTION OF TALL FESCUE

The fact that tall fescue produces more dry matter than most other cool season grasses commonly grown in the Southeast has been well documented (Ronningen et al., 1955; High, 1960; High et al., 1965a; Hobbs et al., 1965; Blaser et al., 1969). Reid and Jung (1965) found that the addition of nitrogen fertilizer significantly increased protein digestibility in either first or aftermath cuttings of tall fescue hay. Several researchers noted the beneficial effect of seeding legumes in tall fescue sod. Hoveland et al. (1979) stated that tall fescue grown in combination with ladino clover without nitrogen fertilization produced forage yields equal to that of fescue fertilized with 150 pounds of nitrogen. Evans (1980) reported that including three pounds of red clover seed per acre during the establishment of tall fescue resulted in as much forage production during the first year

as did fertilization with two hundred pounds of nitrogen fertilizer per acre at establishment. However, the incorporation of legume into fescue sod stimulated grass growth, and this ultimately resulted in competition with the legume and, eventually, total elimination of the legume content of the pasture (Whitehead, 1970; Woodhouse and Chamblee, 1958; High, 1960; High et al., 1965a; Hobbs et al., 1965).

More satisfactory renovation of fescue sod with legumes may be obtained if the sward is thinned either by chemicals or by mechanical methods (Anderson and Safley, 1966; Fribourg, 1962). A pasture may be in equilibrium with the environment under certain management practices. However, if pasture management procedures are altered, the pasture begins to revert to some other form of vegetation. Therefore, pasture management techniques (choice of species, date of seeding, density of seeding, fertilization, irrigation, and time and height of defoliation) are utilized in order to secure a desirable balance of grasses and legumes within the pasture (Haynes, 1980).

## IV. BEEF PRODUCTION ON TALL FESCUE PASTURE

Since the early 1950's, beef production on tall fescue pastures has been a high priority research subject in areas adapted to this grass. Ronningen et al. (1955) found that beef gains per acre were similar for orchardgrass-ladino clover (296 lb), fescue-ladino clover (292 lb), and bluegrass-white clover (292 lb) pastures. Although forage yields were higher (2.03 ton per acre) from the fescue-ladino clover pastures than from orchardgrass-ladino clover pastures

(1.86 tons per acre) or Kentucky bluegrass-white clover pastures (1.54 tons per acre), the conversion into beef was less efficient. The orchardgrass-ladino clover stands were less persistent and became less dense than the other two stands over the six-year study. White (1960) indicated, however, that rate of gain of animals on pasture is a function of the pasture's clover content. Data from the trials he summarized suggested that average daily gain increased as clover content increased.

Fescue pastures produced more total beef per acre during the winter grazing season in Tennessee than other cool season grasses (High, 1960; High et al., 1965a,c; Hobbs et al., 1965; Jones et al., 1974). However, animals grazing orchardgrass, bluegrass, orchardgrass-ladino clover, or bluegrass-white clover pastures consistently produced higher spring and summer average daily gains than did animals grazing fescue alone or fescue in combination with ladino clover (High, 1960; High et al., 1965a,c; Hobbs et al., 1965; Wang, 1968; Blaser et al., 1969; Davis, 1969; Smith et al., 1975). Tall fescue also consistently provided more animal grazing days and had greater persistence of stand than did other grasses (High, 1960; High et al., 1965a,c; Hobbs et al., 1965; Anderson and Safley, 1966; Blaser et al., 1969). Due to the extended availability of forage for fall grazing, hay consumption of cattle grazing fescue during the winter months was approximately one half that consumed by animals grazing orchardgrass (High et al., 1965a). Combined summer and winter average daily gains favored other cool season grasses even though fescue theoretically was nutritionally

similar to them. According to High et al. (1965a), yearling steers consumed thirty pounds of fescue and ladino-clover forage for each pound of gain but consumed only sixteen pounds of orchardgrass-ladino clover forage for each pound of gain. Hobbs et al. (1965) stated that yearling steers grazing fescue pastures made 40% of their total gain in the winter season and 60% of their total gains in the summer. On the other hand, yearling steers grazing orchardgrass pastures made 20% of their total gain in the winter and 80% during the summer grazing period.

Renovation of grass pastures with legumes increases average daily gain of beef cattle. Smith et al. (1975) indicated that the effects of renovation of fescue pastures with ladino clover in late winter on animal gains were equal to those of one hundred pounds of nitrogen fertilizer applied to orchardgrass pasture and were better than one hundred pounds of nitrogen fertilizer applied to fescue pastures. Average daily cow gains and conception percentages were .70 lb, 90%; .11 lb, 72%; and .68 lb, 92% for orchardgrass pastures fertilized with one hundred pounds of nitrogen per acre, fescue pastures fertilized with one hundred pounds of nitrogen per acre, and fescue pastures renovated in late winter with ladino clover, respectively. Part of the increase in average daily gains associated with increase in clover content of the pasture can be explained by the fact that cattle prefer plants with higher protein content and selectively graze these when available (Wang, 1968; Coleman and Barth, 1973). High et al. (1962) found no difference between gains of

steers grazing perennial orchardgrass-fescue-clover pastures or those of steers grazing perennial pastures supplemented with rye grass-crimson clover annual pasture in the winter and millet pastures in the summer.

The response of fescue to nitrogen fertilization in terms of (1) extra dry matter production, and (2) more grazing days per unit area or greater carrying capacity has been well documented (High, 1960; High et al., 1965a,c; Hobbs et al., 1965; Blaser et al., 1969; Cope et al., 1972; Stricker et al., 1979). However, the present high cost of nitrogen fertilizer makes this practice less attractive when returns on investment are considered (Blaser et al., 1969; Cope et al., 1972; Petritz et al., 1980).

Holloway et al. (1979) compared high quality pastures (fescue and clover clipped to maintain vegetative growth) and low quality pastures (fescue alone allowed to mature without clipping). In a five-month trial from April 29 to September 28, cows grazing high quality pastures gained forty pounds more than cows grazing low quality pasture and subcutaneous fat of the cows increased .11 inches more. Calves grazing high quality pastures were forty pounds heavier at weaning than those grazing low quality pastures. Cows grazing the two pastures produced similar volumes of milk, but cows grazing high quality pasture produced milk that contained .42 percentage units more fat than those on low quality pastures. In a later experiment, Holloway et al. (1982) found that claves grazing fescue-clover pastures grew faster, consumed more milk and forage and consumed

forage of higher available energy than did those grazing fescue alone. Conversely, calves grazing straight fescue were more efficient in converting digestible energy in milk and forage to gain. They depended largely on milk while calves grazing fescue-clover pastures depended more on forage. Calves nursing cows with low milk production and consuming low quality forage did not increase forage intake to compensate for the lower quality. However, calves grazing the high quality pasture and nursing cows with low milk production consumed more forage to compensate for the low milk intake.

Blaser (1972) found that when calves between the ages of four and seven months were restricted to a diet of milk only, they gained .33 pounds per head per day. However, calves on the same restricted milk diet and supplemented with corn silage gained 1.97 pounds per head per day. Gains of calves fed corn silage ad lib were not affected by their dams' energy intake although the dams were fed to gain .55 pounds per day or lose 1.09 pounds per day. It was noted also that when cows and calves were maintained on pastures with a relatively low amount of available forage and the calves were allowed to creep graze pasture with abundant high quality forage, the creep-grazed calves gained 40% more than did those not allowed to creep graze. Two stocking rates were used in this experiment; 1.7 acres per cow-calf unit and 2.2 acres per cow-calf unit. Live-weight gains per animal were similar for both stocking rates; however, the higher stocking rate allowed an increase in live-weight gains per acre of 19% without serious damage to pasture stands.

# V. MANAGEMENT AND STOCKPILING

Stockpiling, the practice of accumulating tall fescue forage for winter grazing, has been a common practice of beef cattle producers throughout the Southeast. Due to its tolerance of cold weather, its ability to grow and produce forage at temperatures as low as 40°F, and its response to nitrogen fertilization or renovation with legumes, fescue has consistently produced a significant amount of winter forage for beef cattle. In a Georgia yield study involving one-year-old fescue stands, McVickar (1974) found that green forage available for grazing in late November was 6,000 pounds (dry weight) per acre compared to less than 1,000 pounds (dry weight) yield from early season heavily-fertilized temporary pastures. A review regarding stockpiling of tall fescue by Matches (1979) evaluated and documented several aspects of the practice including: (1) period of accumulation, (2) effects of summer defoliation on stockpiled yields and winter growth, (3) comparison of tall fescue with other grasses for stockpiling, (4) response of stockpiled tall fescue to nitrogen fertilization, and (5) seasonal variation of yields and losses in stockpiled tall fescue.

Discussion of fescue management is interspersed throughout other sections. In addition, research relating to the management of tall fescue was reviewed extensively by Matches (1979). Particular attention was given to:

1. season-long management of tall fescue:
   (a) tall fescue grown alone;
   (b) tall fescue-legume mixtures.
2. stockpiled tall fescue for autumn and winter grazing:
   (a) period of accumulative growth;
   (b) effects of summer defoliation on stockpiled yields and winter growth;
   (c) comparison of tall fescue with other grasses for stockpiling;
   (d) response of stockpiled tall fescue to nitrogen fertilization;
   (e) seasonal variation in yields and losses in stockpiled tall fescue.
3. nitrogen fertilized tall fescue and tall fescue legume mixture:
   (a) nitrogen fertilized tall fescue;
   (b) tall fescue with legumes and nitrogen.
4. interseeding tall fescue into bermudagrass.
5. tall fescue cultivars and grass species—a comparison of yield and quality:
   (a) tall fescue cultivars yield and quality;
   (b) quality trends;
   (c) how tall fescue compares with other grasses.

# VI. FESCUE TOXICOSIS

Tall fescue is an excellent forage crop especially in the southeastern United States. However, producers occasionally see disorders in animals grazing tall fescue at different seasons of the year and under many different environmental conditions.

Animal signs associated with fescue toxicosis have been described in detail by many authors (Cornell et al., 1982; Wilkinson et al., 1983; Williams et al., 1969; Bush et al., 1979) and generally include reduced rate of gain and (or) milk production and rough hair coat. The principal syndromes or terms associated with fescue toxicosis are fescue foot, low performance, summer syndrome, summer slump, and fat necrosis. The extreme symptoms of fescue foot (Cornell et al., 1982) and fat necrosis (Wilkinson et al., 1983) are easily recognized and diagnosed, however it is not known whether they represent different animal responses to the same toxic agent(s) or less acute visual responses associated with lower summer forage quality and the accompanying poor performance.

## Fescue Foot

An extensive review of literature on fescue foot was written by Bush et al. (1979) and by Cornell et al. (1982). The likelihood of fescue foot occurrence in Kentucky 31, Kenhy, Mo-96, Kenmont, and Fawn fescue was evaluated by Cornell et al. (1982) in a three-year trial at the University of Missouri. Kentucky 31 exhibited more toxicity than did the other cultivars during two out of three years.

Kenhy, Mo-96, and Kenmont were intermediate in toxicity symptoms and Fawn was consistently the least toxic. The specific compound(s) that produces fescue foot in cattle grazing tall fescue remains unidentified. However, goats show promise as a suitable assay animal for testing forage extracts for fescue foot potential via the intraperitoneal injection-video-thermometry technique (Garner et al., 1982).

- Fat Necrosis

Bovine fat necrosis was observed by Forney et al. (1969), Williams et al. (1969), Stuedemann et al. (1973), and Stuedeman et al. (1975) in animals grazing tall fescue pastures, and is defined as the presence of masses of hard or necrotic fat primarily in the adipose tissue of the abdominal cavity. It is found mostly in mesenteric fat immediately surrounding the intestines but may be found wherever there is a concentration of adipose tissue. Hard fat may surround and constrict intestines causing digestive disburbances or death. It may surround the ovaries or birth canal also, preventing conception or normal birth (Wilkinson et al., 1983). Fat necrosis has been more often observed in cattle grazing fescue pastures heavily fertalized with large amounts of broiler litter (Williams et al., 1969; Forney et al., 1969). However, subsequent research has shown that fat necrosis can occur also in cows grazing fescue fertilized with amonium nitrate and (or) broiler litter (Stuedemann et al., 1973; 1975).

Summer Syndrome

The general poor performance of animals grazing fescue during the summer months probably has a greater economic impact on cattle operations than any other problem associated with fescue. Researchers have studied this problem extensively, and several theories have developed regarding the cause of the characteristic loss of weight, rough hair coats, diarrhea, increased respiration, elevated body temperature, nervousness, long periods of standing in water and long hours spent in the shade. These theories involve (1) tall fescue alkaloids, (2) vasoconstrictor alkaloids of ergot, (3) ergot-like vasoconstrictor alkaloids, (4) mycotoxins produced by fungi in or on the grasses or toxins produced by tall fescue in response to fungal infection or nematode invasion, (5) a toxin (not present in or on the plant) which is produced in the animal's rumen by microbial action, and (6) an anion (a negatively charged compound that can be absorbed onto an anion exchange resin) present in the plant, which under stress (cold, heat, drought, nitrogen content of the soil too high or too low, etc.) increases to a level which is toxic to cattle (Bush et al., 1979).

Merriman et al. (1962) reported that feed consumption and weight gains of cattle consuming tall fescue seed were significantly less than for cattle consuming either a corn and cottonseed meal diet or ryegrass seed alone. Early work by Jacobson et al. (1963) and Walls and Jackson (1970) postulated a vasoconstrictor as the causative agent in the winter syndrome when tail and foot gangrene and lameness were

produced. It was further postulated by Jacobson et al. (1963) that lameness and gangrene in cold weather may give way to elevated body temperatures and respiration rates as clinical symptoms of toxicity in warmer weather. Jacobson et al. (1970) compared three other grasses (orchardgrass, bromegrass, and bluegrass) to five fescue cultivars. In a twelve-year pasture study, differences in animal productivity between the fescues and the other grasses were generally statistically significant even though Kentucky 31 and Kenwell fescue varieties produced gains similar to those on the other grasses in some years. Fescue toxicity symptoms were more prevalent on the GI-43, 45-50, and pt(t) fescue varieties and animal performance also was lower on these varieties than on Kentucky 31 and Kenwell.

The toxic alkaloid theory has been studied by several researchers. Loveland et al. (1976) found perloline content to be highest during warm weather and lowest in stockpiled fescue. This may be a useful tool if in fact perloline alkaloid is associated with summer syndrome. Tall fescue strain (GI-307), bred and selected for low perloline content, consistently produced lower gains, and grazing animals exhibited more symptoms of summer syndrome than those grazing Kentucky 31, Kenhy, and GI-306 fescue (bred and selected for high perloline content). The poor performance of GI-307 was not attributed to low forage digestibility but to the fact that its content of other alkaloids was evidently increased during the process of selection against perloline (Hemken et al., 1979; Steen et al., 1979; Boling and Hemken, 1981). Hemken et al. (1981) studied

strains GI-306 and GI-307 (the 307 strain was known to produce more toxic symptoms in cattle) of tall fescue and reported that at temperatures above 88°F the cattle grazing strain GI-307 had lower dry matter intake, higher rectal temperatures, higher respiration rates, and lower weight gains than did cattle grazing GI-306. At lower ambient temperatures, differences in dry matter intake, rectal temperatures and respiration rates were not statistically significant. These results demonstrated that poor performance of cattle grazing tall fescue is related to environmental temperature and that the toxic substance is present throughout the growing season since the experiment was conducted during May, July, and October.

Although fungus (Acremonium coenophialum Morgan-Jones and Gams) infestation of tall fescue was documented by Neil as early as 1941, this theory has been the most recent area of intensive attention to researchers of fescue toxicosis. In a pasture test in Alabama, Hoveland et al. (1979) and Hoveland et al. (1980b) discovered that Kentucky 31 fescue produced unusually high gains in grazing steers. The checking of the test pastures for the endophyte fungus revealed that part of the pastures were fungus free and others were fungus infected. This discovery inspired additional evaluation of these stands with similar results (Hoveland et al., 1980b). Hoveland et al (1980a) compared fungus-infested tall fescue postures to non-infested pastures and observed that steers gained .5 pound per day more on noninfested pastures. Schmidt et al. (1982) fed fungus-infested seed and hay as opposed to fungus-free seed and hay and

found that gains and feed intake were less on the fungus-infested diets. Pederson (1982) in an Indiana study found that the rate of gain of cattle grazing fungus-free tall fescue pastures were approximately twice that of cattle grazing fungus-infected pastures. In a four-year study at the Alabama Black Belt Substation, Hoveland et al. (1983) found that average daily gain was 60% higher on fungus-free pastures than on fungus-infected pastures, and that in three out of four years average daily gains on fungus-free pastures were twice those on fungus-infected pastures. It was noted also that the conception rate of cows grazing fungus-free pastures was 92% versus 71% for those grazing fungus-infested pastures.

Fungus-free fescue seed seems to show promise in the future, due to the belief that fungus infestation is a seed-borne disease. However, at present, the best method available to producers for control of fescue toxicosis appears to be the establishment of legumes in tall fescue pastures (Hoveland et al., 1981; Pederson, 1982).

## Nitrate Toxicity

The nitrate toxicity literature was reviewed in detail by Wright and Davison (1964) and Singer (1972). Nitrate accumulations in plants may result from plant characteristics and (or) environmental factors. Stems usually contain more nitrate than leaves, and leaves contain more nitrate than floral parts (Wright and Davison, 1964). The most important factor in nitrate accumulation is the nitrogen availability in the soil; the higher the soil nitrogen the greater the nitrate accumulation in the plant (Wright and Davison, 1964).

If high soil nitrogen is associated with adequate potassium, greater nitrate accumulation will occur than if sodium or some other cation must be absorbed with the nitrate. Phosphorus has had a variable influence on nitrate accumulation. High levels of nitrate are often associated with moisture stress (Bush et al., 1979).

Moisture must be available in sufficient amounts and over a long enough period to permit suitable plant growth before nitrate is accumulated, but moisture stress slows the rate of nitrate reduction in the plant while the soil is still wet enough to provide for nitrate uptake. Under these conditions, accumulation of nitrate may proceed rapidly. Reduction in light intensity also is associated with an increase in nitrate content. Temperature is often compounded with moisture stress and light; when it is not, the influence of temperature depends on type of plant and source of nitrogen (Wright and Davison, 1964).

Tall fescue accumulates significant amounts of nitrate and is grouped with other cool season grasses such as orchardgrass, bromegrass, and timothy in potential to accumulate nitrate. Tall fescue generally accumulates nitrate to a lesser extent than sudangrass, sorghums, corn, and small grain, but to a greater extent than bluegrass, alfalfa, red clover, and ladino clover (Bush et al., 1979).

Nitrate toxicity is actually misnamed, It should be nitrite toxicity. Ingested nitrates are metabolized (reduced) in the rumen in a series of steps from nitrate to ammonium; nitrate → nitrite → nitrate oxides → hydroxylamine → ammonia. Nitrates may not be

reduced at all, or may be reduced to one of the intermediate forms and accumulate. The rate and degree of reduction depends on the type of microflora present in the rumen and the type of food ingested (Sapiro et al., 1949; Wang et al., 1961).

### Ammonium Toxicity

Although ammonium toxicity is not considered a serious problem with tall fescue forage, there is a possibility of this, particularly on pastures that have been heavily fertilized with nitrogen (Bush et al., 1979).

## VII. GRASS TETANY

Grass tetany (hypomagnesemia) in cattle has been extensively reviewed and summarized by Bush et al. (1979), and Grunes et al. (1970). Grass tetany occurs when cattle or sheep graze grass, small grains, or forages in cool weather, mainly in early spring. Pregnant or lactating animals are most susceptible (Bush et al., 1979). The primary cause of the disease is low magnesium in the forage, but high concentrations of nitrogen and potassium in the forage can be contributing factors (Miller et al., 1980). Other factors that may be involved are low concentrations of carbohydrates and high concentrations of trans-aconitic acid, citric acid, and certain higher fatty acids (Bush et al., 1979).

The disease may be prevented by magnesium fertilization of acid, course textured soils. However, because of higher absorption

capacities of fine textured soils, and lower solubilities of Mg $CO_3$ in soils of high pH, higher rates of magnesium fertilizer would generally be required in these cases (Grunes et al., 1970). This is more expensive, and in these cases it may be better to supply magnesium by oral supplementation, including legumes, adding magnesium to feed or salt, or foliar applications of magnesium oxide to the forage. Another possible solution is the use of magnesium bullets in the rumen of cattle and sheep, but more research is needed concerning the effectiveness of this method (Grunes et al., 1970; McLaren and Bell, 1978). A long-term solution may be the breeding and selection of legumes that grow as early in the season as cool season grasses, and the breeding of grasses containing high concentrations of magnesium (Grunes et al., 1970).

# CHAPTER III

# MANAGEMENT OF FESCUE PASTURES FOR BEEF COWS

## I. INTRODUCTION

The continued increase in land, labor, materials, equipment, fertilizer, and seed costs have resulted in lower profits from beef production. These increases have required beef producers to maximize production per acre of pasture land. Tall fescue is one of the hardiest grasses in the Upper Mid-South, therefore, it is important that it be included in management systems directed toward maximized beef production per acre with minimized costs.

There are several problems associated with the production and utilization of tall fescue pastures. A period of summer dormancy is exhibited under hot and dry conditions. If fescue growth is not removed by grazing or clipping it becomes very unpalatable. It has been suggested also by Bush et al. (1979) that fescue contains certain undesirable constituents which are, in part, responsible for the erratic nutritional quality of tall fescue and the subsequent low performance of animals grazing fescue during late spring and summer (Merriman et al., 1962; Jacobson et al., 1970; Hoveland et al., 1980b). Certain health problems such as "fescue foot" or typical dry, rough hair (fescue) syndrome also may result from grazing fescue pastures (Merriman et al., 1962; Cornell et al., 1982). Excessive

salivation and elevated body temperatures also have been reported in cattle grazing fescue pastures.

Especially in the Upper Mid-South, tall fescue has many advantages. Its production can be greatly modified by the addition of nitrogen (High et al., 1965b,c) (N) fertilizer, and it exhibits less winter dormancy at temperatures above 34°F (Leasure, 1952). Relatively high palatability and (or) nutritive quality is retained for a long period of time during winter. Several types of legumes complement its nutritive value if properly managed to maintain a desirable legume-grass ratio (Hoveland et al., 1981a). In addition, it grows on relatively infertile, wet soils (Cowan, 1956) and produces relatively large amounts of forage when soil pH is below the minimum required for satisfactory growth of most pasture species (Buckner et al., 1979). Persistence of stand is probably the most important advantage of fescue compared to other pasture species. Fescue stands remain viable even under intense grazing pressure and during extended periods of drought which would significantly reduce or destroy other pasture stands.

## II. OBJECTIVES

The overall objective of the series of experiments included in this study was to develop fescue-pasture-management systems which improve forage production and utilization if used by Upper Mid-South cow-calf producers. Specific objectives of individual experiments (phases) were to (1) compare cultivars (Kentucky 31 vs. Kenwell),

(2) study the effects of renovation (introduction of legumes into fescue sods) and level of nitrogen fertilization on animal performance and pasture productivity, (3) evaluate overseeding (renovation) methods, and (4) compare extensive vs. intensive pasture management systems.

## III. PROCEDURE

### Experimental Design

The eight 10-acre pastures at the Highland Rim Experiment Station (HRES), Springfield, Tennessee, used in this study varied with respect to soil types. However, four pastures contained predominantly Baxter cherty silty clay loam soil with 5 to 20% slope. These pastures had previously been terraced to reduce erosion. The other four pastures contained mainly Sango silt loam and Dickson silt loam soils with 2 to 5% slope (Anderson and Safley, 1966). Therefore, in all experiments during this study, the experimental design was a randomized complete block with pastures blocked on soil type combinations. Each trial, with the exception of Phase I, consisted of four treatment levels and two blocks. The treatments compared during the various experiments were:

Phase I (1967-1969).

(1) Kenwell fescue + ladino clover

(2) Kentucky 31 fescue + ladino clover

Phase II (1970-1973).

(1) Fescue pasture without renovation or nitrogen fertilization.

(2) Fescue pasture plus 75 pounds of nitrogen fertilizer per acre (spring and fall).

(3) Fescue pasture renovated with ladino clover.

(4) Fescue pasture renovated with ladino clover, Kobe lespedeza and red clover.

Phase III (1973-1978).

(1) Fescue pasture plus 75 pounds of nitrogen fertilizer per acre (spring and fall).

(2) Fescue pasture plus 150 pounds of nitrogen fertilizer per acre (spring and fall).

(3) Fescue pasture overseeded with legumes each spring plus 75 pounds of nitrogen per acre in the fall.

(4) Fescue pasture renovated with legumes annually.

Phase IV (1980-1983).

(1) Fescue pasture renovated with legumes once each 3 to 4 years by methods involving minimum tillage.

(2) Fescue pasture renovated with legumes annually by minimum tillage methods.

(3) Fescue pasture renovated with legumes once each 3 to 4 years using the "Zebra procedure" of band application of paraquat.

(4) Fescue pasture renovated with legumes each spring

using minimum tillage methods and fertilized with 75 pounds of nitrogen fertilizer per acre each fall.

Renovation Methods

In order to insure satisfactory results of overseeding legumes in established fescue sods and establishing more desirable legume-grass ratios, fescue sods were thinned and overseeded by one of the following methods.

1. Minimum tillage. In preparation for overseeding, the fescue sod was grazed extremely close (to the extent sods other than tall fescue would sustain severe damage), and overseeding was done with a grain drill set to a depth of one-half inch or broadcasting with cattle remaining on the pasture with their trampling resulting in seed coverage.

2. Disking. Mechanical thinning was done by repeated disking of the fescue until a minimum of 50% of the fescue was killed. Overseeding was done with a grain drill or broadcasting. If the seed were broadcast, they were covered by light disking or by harrowing. This method required that the cattle be removed from the pasture until the seedbed was firm and the seedlings established (30 to 60 days).

3. Zebra or paraquat method. Following removal of surplus forage by grazing (pasture forage was defoliated to about one-inch height), renovation was accomplished by a commercial pasture renovation machine. The machine applied paraquat at the rate of 1 pound active ingredient per acre in alternate four-inch bands.

The soil within the sprayed band, where the fescue was killed, was prepared to receive the legume seed by disk or rotatiller attachments, and the seed were applied in a single operation. This method required the removal of the cattle following renovation and resulted in alternate four-inch bands of fescue and legumes. This banding pattern resulted in the name "Zebra method."

In the fall of 1966, four of the eight pastures that had been previously seeded to Kentucky 31 fescue (two in each block) were heavily disked and overseeded with ladino clover, and four pastures were seeded to Kenwell fescue and ladino clover at the rate of 12 pounds of fescue seed and 2 pounds of ladino clover seed per acre. In the early spring of 1968 all pastures were overseeded with ladino clover (1 pound seed per acre) by the minimum tillage method. In February 1969, all pastures were overseeded with 1 pound of ladino clover and 4 pounds of Kobe lespedeza per acre.

In the spring of 1970 (Phase II), two pastures were renovated by disking to reestablish ladino clover (2 pounds seed per acre) and two pastures were renovated by disking to establish ladino clover, red clover and Kobe lespedeza (2, 4, and 8 pounds of seed per acre, respectively). Each spring (1971-73) these pastures were overseeded with ladino clover (1 pound seed per acre) or ladino clover, red clover, and Kobe lespedeza (1, 2, and 4 pounds per acre, respectively).

During 1974 through 1978 (Phase III), the fescue, ladino clover, and lespedeza stands in two pastures (Treatment 4) were maintained by the annual overseeding procedure used in Phase II. Two of the

pastures containing legumes were fertilized each fall with 75 pounds of nitrogen per acre. These pastures were renovated by the minimum tillage method each spring to reestablish the ladino clover, red clover, and lespedeza.

During 1979, all pastures were nitrated in February at the rate of 75 pounds per acre in order to equalize pasture fertility and legume content. In the spring of 1980, two pastures were randomly assigned to the four treatments. Two pastures were renovated with ladino clover, red clover and lespedeza using the minimum tillage method, and two pastures were renovated by the Zebra treatment. These pastures were not overseeded in subsequent years. Two pastures were overseeded each spring (minimum tillage method) with ladino clover, red clover, and lespedeza without fertilization. The remaining two pastures were fertilized each year in August, and stockpiled forage was used for winter feed. These two pastures were renovated each spring by the minimum tillage method.

All pastures were fertilized with phosphate, potassium and lime according to soil test recommendations based on annual fall soil samples. Each year (1967-78), nitrogen was applied to all designated pastures in the form of ammonium nitrate.

## Animals and Their Management

During the earlier phases of the study, Hereford cows and their Hereford or Angus x Hereford calves were selected from the HRES herd. In later years, Angus x Hereford cows and their calves, sired by Red Poll bulls, were used. Each fall, in October, all cows were

pregnancy checked and any cow diagnosed open was removed from the experimental pastures. Each open cow was replaced by a pregnant cow with similar performance records from the general HRES herd. As long as forage was available, cows were wintered in their respective pastures on stockpiled or residual forage. When pasture forage was no longer available in the respective pastures, cows were fed 12 to 18 pounds of medium-quality, mixed-grass hay per cow per day.

Cows in each experimental pasture were fed supplemental magnesium from November through April each year to minimize the risk of grass tetany. Several different carriers of supplemental magnesium were used during the 18-year period, and the incidence of clinical tetany in cows grazing the experimental pastures was lower than that in an adjacent nonsupplemented herd. Serum and whole blood samples were generally taken from each cow by jugular puncture at monthly intervals during the winter. These serum samples were analyzed for mineral content. Individual cows were considered hypomagnesiemic and treated with intravenous magnesium-calcium solution when clinical symptoms were observed or when serum magnesium concentration was below 1 mg.100 ml.

The cows were exposed to bulls from April 10 to July 15 and the resulting calves were born on the respective pastures in February, March, and April. Castration and dehorning (when needed) were done at birth or soon after. Calves were vaccinated for blackleg and malignant edema at about 120 days of age and again at weaning.

All experimental cows and calves were weighed when the trial started each year (about November 1), at the beginning of the lush spring pasture growth season (about April 1), at the beginning of summer (about July 1), at weaning (in October), and at about 56-day intervals between these designated weigh periods. Cows were scored for condition (fatness) in November, April, and October, and calves were scored with respect to condition and conformation at weaning. Other management practices—salt and mineral availability, parasite control, cow vaccination program, etc.—were based on U.T.-Animal Science Department recommendations.

Pasture Management

The stocking rate in all trials was one cow-calf pair per two acres. However, during the lush forage growing period each spring, extra cows and their calves were added in a modified put and take grazing system to remove excess forage. Rotational grazing was practiced with a single-strand electric fence dividing each pasture into two sections. Each pasture was subjectively scored at regular intervals each year (biweekly in the earlier years and less frequently in subsequent years), and species composition of the sward, height and vegetative condition of each species, and pasture quantity and quality were noted. At least 3 pasture clippings ("grab" method) were taken from each pasture during each grazing season and subjected to routine chemical analysis. Daily rainfall was recorded and summarized by month and year throughout the entire experiment.

Data Collected

In general, the productivity of the various management systems were evaluated during segments of the annual forage growth pattern. These segments were Winter (about November 1 to about April 1), Spring (about April 1 to about July 1), and Summer (about July 1 to weaning which generally occurred in late October). Cow weight changes during winter and total winter hay intake per cow were considered to reflect the effect of the respective management system on winter feed production. Since most calves were born in February or March, cow weight changes reflected also the effects of pasture management systems on animal management.

The spring production segment coincided with the lush spring forage growth season and with the breeding season. Cow and calf weight changes and cow conception during this period were evaluated with respect to management-system effects. The summer coincided with the generally reported semi-dormancy of fescues, the period of greatest suppressed gains, and the most stressful part of the pasture year.

Overall productivity was evaluated in terms of calf 240-day weights. Calf weaning weights were converted to an adjusted 240-day weight, adjusted for sex of calf and age of dam using the procedures described by Robertson (1974). The procedure was as follows:

$$240\text{-Day-WT} = \left(\left(\frac{WW-BW}{WA}\right) \times 240\right) + \left(b_1 \times (WA - 240)\right)$$
$$+ \left(CF_{sex} \times \left(\frac{WW-BW}{WA}\right) \times 240\right) + \left(CF_{age} \times \left(\frac{WW-BW}{WA}\right) \times 240\right) + BW$$

where:

240-Day-WT = weaning weight adjusted to a constant age (240 days), sex (steer), and age of dam (mature, 6- to 10-year-old basis);

WW = actual weaning weight;

BW = actual birth weight;

$b_1$ = a regression coefficient (-.247) proposed by Robertson (1974) to remove adjustment bias due to curvilinear growth of calves;

$CF_{sex}$ = multiplicative adjustment factor to adjust all calf gain to a steer basis (Robertson, 1974);

$CF_{age}$ = multiplicative adjustment factor to adjust all calf gain to a mature-cow basis (Robertson, 1974).

All weight changes and other estimates were adjusted to an average calf age, sex of calf, and age of dam basis by including these variables as covariates in the statistical models evaluating these dependent variables (Henderson, 1953).

Summarization, Analysis, and Evaluation

Cow and calf weight change during winter, spring, and summer were used to evaluate the productivity of pastures managed according to the various systems (renovation and/or fertilization). Calf weaning weight was transformed to reflect productivity per unit of pasture during spring-summer, and cow hay intake was used to reflect pasture productivity during winter. Analysis of variance was performed for each experiment to assess the effect of the independent variables

(year, block, pasture management system, etc.) and interactions among them on the dependent variables (measures of pasture quality and pasture productivity).

## IV. RESULTS

The results presented here are from a series of four experiments designed to: (1) evaluate two tall fescue cultivars, (2) to compare nitrogen fertilization and renovation to establish desirable grass-legume ratios, (3) to evaluate management practices which incorporate the important advantages of nitrogen fertilization and renovation in the same fescue stand, and (4) to estimate the efficacy of various methods and frequencies of renovation of fescue pastures.

In the fall of 1966, four pastures were disked several times to establish a new stand of Kentucky 31 fescue and ladino clover, and four pastures were seeded to Kenwell fescue and ladino clover. During subsequent trials, each pasture treatment was imposed on one pasture containing Kentucky 31 fescue and one pasture containing Kenwell fescue. In these studies a satisfactory evaluation of the effect of the various management treatments on reproductive performance was difficult. Due to the necessity for replication of treatments, experimental units were 10 acre pastures grazed by five tester cows with a modified put-and-take system. In order to allow natural pasture mating, each bull was rotated, twice daily, between two adjacent pastures subjected to different pasture management systems.

Infrequent problems associated with low fertility in some bulls and the fact that the practice of rotating bulls may have resulted in the service of some cows at less than optimum times during estrus may have resulted in lower than desired overall reproductive performance. However, strong trends with respect to the influence of specific factors (such as management systems) on reproductive performance were observed. These trends were generally similar across years and are presented with other data.

Kentucky 31 vs. Kenwell Fescue

Average spring-summer performance of calves grazing Kentucky 31 or Kenwell fescue pastures seeded in combination with ladino clover is presented in Table 1. Calves were born on their respective pastures between January 15 and April 1. The average birth dates were similar on the two cultivars (February 7 and February 10, respectively). Average calf gain (from April 1 to weaning) of calves grazing Kentucky 31 fescue (285 pounds) was similar ($P > .05$) to that of calves grazing Kenwell fescue (283 pounds). Similar trends were observed with respect to actual weaning weight, daily gain, and type and condition scores.

Average cow performance during the three-year period is presented in Table 2. Cow weight at the beginning of the spring-summer grazing season was similar on grazing the two cultivars. However, cows grazing Kentucky 31 fescue tended to gain more weight during the grazing season than did those grazing Kenwell fescue (106 vs. 83 pounds, respectively). Subjective cow condition scores

Table 1. Performance of calves grazing Kentucky 31 or Kenwell fescue pastures (1967-1969)

| Variable | Fescue cultivar[1] | |
|---|---|---|
| | Kentucky 31 | Kenwell |
| Number of calves (3 years) | 60 | 60 |
| Average date of birth | Feb. 7 | Feb. 10 |
| Average weight and gain, lb | | |
| Initial weight, Spring[2] | 141 | 140 |
| Actual weaning weight[3] | 426 | 423 |
| Actual gain (April 1 to weaning) | 285 | 283 |
| Actual daily gain | 1.46 | 1.46 |
| Adjusted 240-day weight | 444 | 442 |
| Average weaning scores[4] | | |
| Type | 11.4 | 11.8 |
| Condition | 9.1 | 9.3 |
| Average pasture legume content, % | 25 | 26 |

[1]All pastures contained ladino clover.

[2]Spring weights were taken about April 1.

[3]Calves were weaned about November 1.

[4]Condition scores ranged from 6 to 14 with 10 considered as the ideal fall condition. Type score of 10 = good and 13 = choice.

Table 2. Performance of cows grazing Kentucky 31 or Kenwell fescue pastures (1967-1969)

| Variable | Fescue cultivar[1] | |
|---|---|---|
| | Kentucky 31 | Kenwell |
| Number of test cows (3 years) | 60 | 60 |
| Average cow age, years | 6.5 | 6.2 |
| Average weight and gain, lb | | |
| Spring weight[2] | 1069 | 1062 |
| Fall weight[3] | 1175 | 1145 |
| Total gain | 106 | 83 |
| Daily gain | .53 | .42 |
| Average cow condition[4] | | |
| Spring | 10.4 | 10.2 |
| Fall | 10.5 | 10.5 |
| Average conception rate, % | 95[a] | 80[b] |
| Average pasture legume content, % | 25 | 26 |

[1]All pastures contained ladino clover.

[2]Spring weights were taken about April 1.

[3]Fall weights were taken about November 1.

[4]Cow condition scores ranged from 6 to 14 with 10 considered to be the ideal fall condition score

[a,b]Means in the same row superscripted with different letters are different ($P < .10$).

at the beginning and end of the grazing season were similar ($P > .05$) on the two cultivars.

Conception rate, measured in terms of calves born the subsequent year, was greater ($P < .10$) in cows grazing Kentucky 31 fescue (95%) than in cows grazing Kenwell fescue (80%). This is difficult to explain since cows grazing both cultivars gained weight during the breeding season and the clover content of pastures containing the two cultivars were similar.

Effect of Nitrogen Fertilization and Renovation

During the second phase, 1970 through 1973, of the series of experiments, the effect of fertilization of fescue pastures with 75 pounds of nitrogen (225 pounds of ammonium nitrate) per acre in the fall and again in the spring, and renovation to establish a desirable grass-legume (ladino clover or ladino clover-Kobe lespedeza) were studied. Average calf performance during the four years is presented in Table 3. Annual average daily gain from birth to weaning was higher ($P < .05$) in calves grazing renovated pastures (1.58 pounds per calf per day) than in calves grazing nitrated or nonnitrated fescue pastures without legumes (1.39 pounds per calf per day). The average 240-day weight of calves grazing fescue-ladino clover pastures (482 pounds) was greater ($P < .05$) than that of calves grazing fescue alone (432 pounds).

In order to evaluate the forage production and quality patterns during the grazing season, calf performance was partitioned into

Table 3. Effects of nitrogen fertilization and renovation of fescue pastures on calf performance (1970-1973)

| Variable | Fescue management system | | | |
|---|---|---|---|---|
| | Control (no treatment applied) | Fertilized, 75 lb N. Spring 75 lb N. Fall | Renovated with ladino clover | Renovated with ladino clover and lespedeza |
| Number of test cows (4 years) | 40 | 40 | 40 | 40 |
| Average weaning age, days | 254 | 250 | 263 | 254 |
| Average weight and gain, lb | | | | |
| Birth weight | 66 | 69 | 68 | 72 |
| Weaning weight | $424^{a}$ | $406^{b}$ | $476^{c}$ | $477^{c}$ |
| Spring daily gain[1,2] | $1.39^{a}$ | $1.48^{a,b}$ | $1.58^{a,b}$ | $1.65^{b}$ |
| Summer daily gain[1,3] | $1.24^{a}$ | $1.05^{b}$ | $1.41^{c}$ | $1.45^{c}$ |
| Annual daily gain[1,4] | $1.40^{a}$ | $1.38^{a}$ | $1.55^{b}$ | $1.61^{b}$ |
| Adjusted 240-day weight, lb[1,5] | $433^{a}$ | $432^{a}$ | $473^{b}$ | $492^{b}$ |
| Calf gain per acre, lb | $221^{a}$ | $310^{b}$ | $255^{b}$ | $271^{b}$ |
| Calf condition score[6] | $8.5^{a}$ | $7.8^{b}$ | $8.6^{a}$ | $8.8^{a}$ |

$^{a,b,c}$Means in the same row superscripted with different letters are different ($P < .05$).

[1]These means are least squares means.

[2]Spring average daily gain calculated from birth to approximately July 1.

[3]Summer average daily gain calculated from approximately July 1 to November 1.

[4]Birth to weaning.

[5]Adjusted 240-day weight was adjusted to remove variation due to differences in weaning age, sex of calf and age of dam.

[6]Calf condition was recorded only in 1971, 1972, 1973; 10 = average good, 13 = average choice.

spring performance (April 1 to July 1), which coincided with both the breeding season and the lush grazing period in spring and early summer, and summer performance (July 1 to weaning) which coincides with the period of low forage growth due to partial dormancy of fescue and includes the season when fescue syndrome is most frequently observed. During the spring grazing season, daily gain of individual calves grazing the nonnitrated control pasture (1.39 pounds per day), the nitrated fescue pastures (1.48 pounds per day), and the fescue-ladino clover pastures (1.58 pounds per day) were not significantly different ($P > .05$). However, the magnitude of the gains suggest that during the lush spring growth period calves grazing nitrated-fescue pastures tend to gain more rapidly than calves grazing non-nitrated fescue pastures and those grazing fescue-clover pastures tend to gain more than calves grazing either of the pasture systems containing fescue alone. Calves grazing fescue-ladino clover-lespedeza pastures gained faster ($P < .05$) than calves grazing the other pastures. During the summer, calves grazing the renovated pastures gained faster (1.43 pounds per day) ($P < .05$) than calves grazing pastures containing fescue only (1.14 pounds per day). Calves grazing nonnitrated fescue pastures gained .2 pounds more ($P < .05$) than those grazing nitrated fescue pastures. This could be due to the fact that the nitrogen resulted in earlier summer dormancy or that it resulted in forage which contained more toxic materials associated with the summer (fescue) syndrome.

The 240-day weight of calves grazing the nonnitrated control pastures (433 pounds) and the nitrated fescue pastures (432 pounds) were similar ($P < .05$). The 240-day weight of calves grazing the fescue-legume pastures (482 pounds) was 50 pounds greater ($P < .05$) than that of calves grazing the nitrated fescue pastures (432 pounds).

When lespedeza was included in the renovation procedure in addition to ladino clover, the 240-day weights of calves grazing these pastures were 20 pounds greater ($P < .05$) than those of calves grazing pastures renovated with ladino clover only and the calf gain per acre was 6% greater. Calf gain per acre, which includes both rate of gain and stocking rate, was lowest for nonnitrated fescue, highest for nitrated fescue pastures, and intermediate for renovated pastures. However, when these values are considered it must be noted that the average spring-summer stocking rate was one cow-calf pair per 1.4 acres of nitrated fescue and 1 cow-calf pair per two acres in the other management systems.

Average individual performance of cows is presented in Table 4. During winter (November 15 to April 1) cows in each management system lost weight. Cows grazing stockpiled fescue (the management system where 75 pounds of nitrogen was applied in the fall) lost less ($P < .05$) weight during winter than cows wintered on nonnitrated or renovated fescue pastures. Less winter feed (hay) was required for the cows grazing stockpiled fescue and hay feeding was not required as early in the winter season as in the other management systems.

Table 4. Effect of nitrogen fertilization and renovation of fescue pastures on cow performance (1970-1973)

| Variable | Fescue management system | | | |
|---|---|---|---|---|
| | Control (no treatment applied) | Fertilized, 75 lb N. Spring 75 lb N. Fall | Renovated with ladino clover | Renovated with Ladino clover and lespedeza |
| Number of test cows (4 years) | 40 | 40 | 40 | 40 |
| Days on pasture, Summer | 205 | 205 | 205 | 205 |
| Days on pasture, Winter | 135 | 135 | 135 | 135 |
| Average weight and gain, lb | | | | |
| Initial weight[1] | 1038 | 1068 | 1085 | 1134 |
| Final weight[1] | 1034 | 1080 | 1126 | 1157 |
| Winter gain[2,7] | -115[a] | -56[b] | -123[a] | -140[a] |
| Spring gain[3,7] | 35[b,c] | 29[c] | 58[a] | 46[a,b] |
| Summer gain[4,7] | 56[b] | 29[c] | 74[a,b] | 80[a] |
| Annual gain[7] | 1[b] | 10[b] | 35[a] | 17[a,b] |
| Cow condition | | | | |
| Initial[5,7] | 9.3 | 9.1 | 9.5 | 9.8 |
| Final[6,7] | 9.9[b] | 9.8[b] | 10.4[a,b] | 10.8[a] |
| Percent cows pregnant in Fall[7] | .79 | .69 | .78 | .80 |
| Percent cows calved | .77[a] | .57[b] | .70[a] | .77[a] |

[a,b,c]Means in the same row superscripted with different letters are different ($P < .05$).

[1]No initial Fall weights for cows in 1969 for the 1970 year.

[2]Winter gain calculated from approximately Nov. 15 of the preceding year to approximately Apr. 1 of the current year.

[3]Spring gain calculated from approximately Apr. 1 to approximately July 1.

[4]Summer gain calculated from approximately July 1 to approximately Nov. 1.

[5]Initial cow condition recorded only for 1972.

[6]Final cow condition recorded in years 1970 through 1973.

[7]These means are least-squares means.

Winter weight loss of cows grazing the nonnitrated and renovated fescue pastures was similar.

Spring gain of cows grazing renovated pastures (52 pounds) was greater ($P < .05$) than that of cows grazing nonrenovated pastures (32 pounds). Spring gains were similar ($P > .05$) for cows grazing nonnitrated (35 pounds) and nitrated (29 pounds), and for cows grazing fescue-ladino clover (58 pounds) and fescue-ladino clover-lespedeza (46 pounds) these gains were similar also. There was a greater difference with respect to summer gains of cows grazing renovated fescue pastures (77 pounds) and those grazing pastures containing fescue only (42 pounds).

Pasture productivity in terms of cow gains and stocking rate per acre are shown in Table 5. During winter, the stocking rate per acre was usually constant since only test cows were wintered on the experimental pastures. Spring and summer stocking rates differed due to the fact that extra cow-calf pairs were used to harvest extra forage produced. The average spring-summer stocking rate for nonnitrated fescue, nitrated fescue, fescue-ladino clover, and fescue-ladino clover-lespedeza pastures was .51, .72, .54, and .55 cows per acre, respectively, and days grazing per acre was 101, 143, 107, and 109 days per acre, respectively.

Overall conception rate was lower than that reported in similar studies (Anderson and Safley, 1967; Smith et al., 1975). However, meaningful trends are suggested by the observed data. The number (or percentage) of cows diagnosed pregnant each fall was similar in all

Table 5. Effect of nitrogen fertilization and renovation on pasture productivity (1970-1973)

| Variable | Fescue management system | | | |
|---|---|---|---|---|
| | Control (no treatment applied) | Fertilized, 75 lb N. Spring 75 lb N. Fall | Renovated with ladino clover | Renovated with ladino clover and lespedeza |
| Grazing days (spring-summer) | 101 | 143 | 107 | 109 |
| Average spring and summer stocking rate, cows/acre | .51 | .72 | .54 | .55 |
| Winter grazing days | 67.5 | 67.5 | 67.5 | 67.5 |
| Average winter stocking rate, cows | .5 | .5 | .5 | .5 |
| Winter hay consumption, lb | | | | |
| Winter cow gain (Nov. 15-Apr. 1), lb | -57.5 | -28 | -61.5 | -70 |
| Spring cow gain (Apr. 1-July 1), lb | 18 | 21 | 31 | 25 |
| Summer cow gain (July 1-Nov. 1), lb | 29 | 21 | 40 | 44 |
| Annual cow gain[1], lb | 0.5 | 6.3 | 18.4 | 9 |

[1]Winter, spring, and summer cow gains per acre will not add to total cow gains per acre because stocking rates per acre were different in the winter.

management systems but the number of cows that actually calved the following spring was lower ($P < .05$) in cows grazing nitrated fescue than in cows grazing the other pastures. This appears to indicate that nitrated fescue may contain some compound or toxin which either increases abortions (thereby lowering calving percentages), or that pregnancy diagnosis is less accurate in cows grazing nitrated fescue.

Combining the Practices of Fall Nitrogen Fertilization and Pasture Renovation on the Same Fescue Sod

Calf performance in Phase III of this study is shown in Table 6. Spring daily gain of calves grazing renovated fescue pastures (1.67 pounds per day) was significantly higher than that of calves grazing fescue fertilized with 75 or 150 pounds of nitrogen each spring (1.32 pounds per day). Spring daily gain of claves whose dams were grazing fescue fertilized with 75 pounds of nitrogen per acre (1.37 pounds per day) was higher ($P < .07$) than that of calves grazing pastures fertilized with 150 pounds of nitrogen per acre each spring (1.26 pounds per day). Wilkinson and Mays (1979) stated that "when nitrogen fertilization is increased, the soluble carbohydrate level of forages decreases."

Summer daily gains of calves grazing renovated fescue (1.73 pounds per day) were higher ($P < .001$) than those of calves grazing spring nitrated fescue (1.26 pounds per day). Calves grazing fescue fertilized each spring with 150 pounds of nitrogen per acre gained .16 pound per day less ($P < .01$) than calves grazing fescue fertilized with 75 pounds of nitrogen per acre each spring. Increases in

Table 6. The effect of fall nitrogen fertilization and spring renovation of the same fescue sod on calf performance (1974-1978)

| Variable | Fertilized, 75 lb N/A Spring, 75 lb N/A Fall | Fertilized, 150 lb N/A Spring, 150 lb N/A Fall | Renovated with ladino clover, lespedeza 75 lb N/A Fall | Renovated with ladino clover lespedeza |
|---|---|---|---|---|
| Number of test calves (5 years) | 50 | 50 | 50 | 50 |
| Number of days on pasture | 242 | 241 | 237 | 240 |
| Average weight and gain, lb | | | | |
| Initial weight | 66 | 65 | 70 | 66 |
| Final weight | 415 | 393 | 488 | 485 |
| Spring daily gain[1,2] | 1.37[b] | 1.26[b] | 1.67[a] | 1.66[a] |
| Summer daily gain[1,2] | 1.34[a] | 1.18[b] | 1.65[c] | 1.81[d] |
| Annual daily gain[1] | 1.45[a] | 1.34[b] | 1.76[c] | 1.73[c] |
| Adjusted 240-day weight[1,4] | 442[a] | 416[b] | 529[c] | 515[c] |
| Calf gain per acre, lb | 380 | 424 | 338 | 278 |
| Calf condition score[5] | 8.3[a] | 8.2[a] | 9.4[b] | 9.2[b] |

[a,b,c,d]Means in the same row superscripted with different letters are different ($P < .05$).

[1]These means are least-squares means.

[2]Spring average daily gain from birth to approximately July 1.

[3]Summer average daily gain from approximately July 1 to Nov. 1.

[4]Adjusted 240-day weight was adjusted to remove variation due to differences in weaning age, sex of calf and age of dam (age of dam coded 2, 3, 4, 5, 6-10, 11, 12, 13, 14).

[5]Calf condition was recorded only in 1974, 1976, 1977.

nitrogen fertilization consistently reduced average daily gains of calves grazing tall fescue.

The 240-day weight of calves grazing renovated fescue pastures were 93 pounds greater ($P < .0001$) than that of calves grazing nitrated fescue pastures. Although the renovated pastures consistently produced higher average daily calf gains, nitrogen fertilized fescue pastures supported 72 more days grazing between April 1 and weaning. This increase in feed production resulted in an additional 94 pounds of calf weaned per acre for nitrated fescue compared to renovated fescue. Economic interpretation of this increased production resulting from nitrated fescue is difficult due to the high cost of nitrogen. Another consideration is the amount and distribution of rainfall received each year. Under conditions of adequate rainfall the response of fescue to nitrogen fertilization is satisfactory; however, when rainfall is below normal or low, nitrogen fertilization may hasten maturity and the onset of dormancy in fescue pastures. During 1974-1978 (Phase III) the annual rainfall was normal or above normal, and this can partially explain the relatively high forage production (days grazing) observed in this trial.

The amount of annual rainfall also affects the success of pasture renovation and clover growth. This was a probable cause of yearly differences in performance of calves grazing the various pastures and of differences observed among the various phases in this study.

Calves grazing fescue pastures renovated with ladino clover and lespedeza each spring gained faster ($P < .03$) during summer than calves grazing similar pastures which had been nitrated the previous fall. Spring gain, average daily gain from birth to weaning, and 240-day weight of calves grazing nonnitrated fescue-ladino clover-lespedeza pastures which were overseeded each spring were similar to those of calves grazing similar fescue pastures that were fertilized with 75 pounds of nitrogen each fall and overseeded with ladino clover and lespedeza each spring. The legume content of the fescue-ladino clover-lespedeza pastures which were not nitrated each fall was greater than that of similar pastures that were nitrated. However, the spring legume content of the pastures receiving fall applications of nitrogen was sufficient to promote gains similar to those produced by nonnitrated and renovated pastures. The fall application of nitrogen (75 pounds per acre) in the renovated fescue pastures resulted in a lower lespedeza content and possibly influenced the summer dormancy of the fescue thereby influencing summer calf gains. The major observation was that the practice of applying nitrogen in the fall (September) in order to stockpile winter cow feed did not reduce weaning weights of the calves.

Average cow performance during Phase III is shown in Table 7. Cows grazing spring nitrated fescue pastures tended to weigh less at weaning each fall than they did the previous fall. Cows grazing renovated pastures tended to weigh more at weaning than they did the previous fall. The difference in annual weight change patterns of

Table 7. Effects of fall nitrogen fertilization and spring renovation of the same fescue sod on cow performance (1974-1978)

| Variable | Fescue management system | | | |
|---|---|---|---|---|
| | Fertilized, 75 lb N/A Spring, 75 lb N/A Fall | Fertilized, 150 lb N/A Spring, 150 lb N/A Fall | Renovated with ladino clover, lespedeza 75 lb N/A Fall | Renovated with ladino clover lespedeza |
| Number of test cows (5 years) | 50 | 50 | 50 | 50 |
| Days on pasture, summer | 202 | 202 | 202 | 202 |
| Days on pasture, winter | 135 | 135 | 135 | 135 |
| Average weight and gain, lb | | | | |
| Initial weight | 951 | 986 | 1049 | 1003 |
| Final weight | 938 | 926 | 1100 | 1072 |
| Winter gain[1,6] | -29[a] | -70[b] | -51[a,b] | -70[b] |
| Spring gain[2,6] | -1[a] | -8[a] | 56[b] | 86[c] |
| Summer gain[3,6] | 2[a] | 3[a] | 38[b] | 44[b] |
| Annual gain[6] | -28[a] | -75[b] | 42[c] | 58[c] |
| Cow condition | | | | |
| Initial[4] | 9.8 | 9.8 | 10.1 | 9.9 |
| Final[5] | 9.2[a] | 9.4[a] | 9.5[a] | 10.4[b] |
| Percent cows diagnosed pregnant[6] | 78[a] | 77[a] | 93[b] | 87[b] |
| Percent cows calved[6] | 64[a] | 58[a] | 81[b] | 80[b] |

[a,b,c]Means in the same row superscripted with different letters are different ($P < .05$).

[1]Winter gains from approximately Nov. 15 of the preceding year to approximately Apr. 1 of the current year.

[2]Spring gain from approximately Apr. 1 to July 1.

[3]Summer gain from approximately July 1 to approximately Nov. 1.

[4]Initial cow condition score recorded only for year 1976, 1979.

[5]Final cow condition score recorded only for year 1977, 1978.

[6]These means are least-squares means.

the two groups was obvious to the herdsman caring for the cows. Cows grazing fescue nitrated in fall appeared fatter in late winter than did those fed hay on renovated pastures. Cows grazing renovated pastures tended to regain any winter weight loss by July 1 while cows grazing spring nitrated fescue lost additional weight during the spring grazing period. Cows grazing renovated fescue continued to gain (41 pounds per cow) during the summer but those grazing nitrated fescue simply maintained their spring weight during this period. These appeared fatter than did cows grazing the nitrated fescue.

Increasing the rate of nitrogen application from 75 pounds per acre (F+75N) to 150 pounds per acre (F+75N) in both spring and fall affected cow and calf performance. The F+150N cows lost 47 pounds more than did the F+75N cows. The additional winter weight loss due to nitrogen fertilization suggests that the optimum nitrogen level for fall stockpiling of fescue was exceeded.

Pasture productivity, in terms of cow gain and carrying capacity per acre, is given in Table 8. The winter stocking rate was constant and was .5 cows per acre for pastures fertilized with 75 pounds of nitrogen in the spring, those renovated in the spring and fertilized with 75 pounds of nitrogen in the fall, and the non-nitrated renovated pastures. Due to the extra fall forage produced in pastures fertilized with 150 pounds of nitrogen in the fall the stocking rate of these pastures was .8 cows per acre. Cows in all pastures were supplemented with 12 to 16 pounds of hay per day when available pasture forage became insufficient to support them. Hay

Table 8. Effect of fall nitrogen fertilization and spring renovation of the same fescue sod on pasture productivity (1974-1978)

| Variable | Fescue management system | | | |
|---|---|---|---|---|
| | Fertilized, 75 lb N/A Spring, 75 lb N/A Fall | Fertilized, 150 lb N/A Spring, 150 lb N/A Fall | Renovated with ladino clover, lespedeza 75 lb N/A Fall | Renovated with ladino clover lespedeza |
| Grazing days (spring-summer) | 179 | 213 | 133 | 114 |
| Average spring and summer stocking rate, cows | .86 | 1.02 | .64 | .54 |
| Winter grazing days | 67.5 | 108 | 67.5 | 67.5 |
| Average winter stocking rate, cows | .5 | .8 | .5 | .5 |
| Winter cow gain (Nov. 15-Apr. 1), lb | -14.5 | -56 | -25.5 | -35 |
| Spring cow gain (Apr. 1-July 1), lb | -.9 | -8.2 | 36.8 | 45.9 |
| Summer cow gain (July 1-Nov. 1), lb | 1.7 | 3.1 | 24.3 | 23.76 |
| Annual cow gain[1], lb | -20 | -70 | 24 | 32 |

[1]Winter, spring, and summer cow gains per acre will not add to total cow gains per acre because stocking rates per acre were different in the winter period.

feeding began earlier in the winter feeding period in pastures not nitrated in the fall, and the pastures fertilized with 150 pounds of nitrogen in the fall did not require supplemental hay until later than did pastures subjected to the other treatments. However, the extra stockpiled forage resulting from the higher nitrogen fertilization rate produced lower cow gains than did pastures not nitrated in the fall or fertilized with 75 pounds of nitrogen in the fall.

During spring and summer extra cows were added to individual pastures to harvest any forage above that required by the test cows and calves, and these extra cows were removed when there was no surplus forage. Spring and summer stocking rates were greater on the spring nitrated fescue pastures than on the renovated pastures. Spring fertilization with 150 pounds of nitrogen per acre resulted in more days grazing than did fertilization with 75 pounds of nitrogen. There appeared to be a spring forage growth stimulating effect in renovated pastures which received fall nitrogen applications. The spring-summer grazing days supported by the two management systems were 133 and 114 days per acre, respectively. Although cows on all management systems lost weight during the winter, cows grazing renovated pastures recovered that weight by July 1 and continued to gain during the summer. This resulted in an annual cow gain per acre of 24 to 32 pounds, but the annual gain for spring-fall nitrated pastures was negative. This difference between renovated and nitrated pastures was probably due to pasture quality having improved by the increased legume content and (or) the reduced

soluble carbohydrates and increased alkaloid and (or) nitrate level of the grass as suggested by Wilkinson and Mays (1979).

Frequency and Method of Renovation

Results of the two previous experiments in this series suggested that renovation of fescue pastures to reestablish legumes produced higher quality pastures which resulted in higher summer and spring cow and calf gain. Fescue pastures fertilized with nitrogen in the spring produced more forage and produced more animal grazing days than did renovated pastures, and renovated pastures produced less winter feed than did fall nitrated fescue pastures.

In the previous studies annual overseeding was used as a research tool to insure pasture differences (adequate legume content of renovated pastures). Two important questions surfaced during the studies. What is the best method of renovating fescue pastures and how frequently should renovation be done? Therefore, four combinations of method and frequency of renovation were studied (Tables 9, 10, and 11).

Average daily calf gain during the spring grazing season was significantly less for calves grazing pastures renovated every 3 or 4 years than calves grazing pastures renovated annually. Calves grazing fescue pastures on which chemicals were used at 3 to 4 year intervals to thin the fescue stand before renovation gained more ($P < .0001$) than calves grazing fescue pastures renovated at the same interval following close grazing to thin the stand. Spring average daily gain of calves grazing pastures chemically thinned and

Table 9. Effects of method and frequency of renovation of fescue pastures on calf performance (1980-1982)

| Variable | Method and frequency of renovation | | | |
|---|---|---|---|---|
| | 3 to 4 Year intervals | | Annual | |
| | Zebra | Minimum tillage | Minimum tillage | Minimum tillage |
| Fall nitrogen, lb/A | 0 | 0 | 0 | 75 |
| Number of test calves (3 years) | 36 | 36 | 36 | 36 |
| Days on pasture | 242 | 241 | 241 | 236 |
| Average weight and gain, lb | | | | |
| Initial weight | 75 | 70 | 73 | 75 |
| Final weight | 506 | 440 | 513 | 532 |
| Spring daily gain[1,2] | 1.81[a] | 1.44[b] | 1.89[a] | 1.95[a] |
| Summer daily gain[1,3] | 1.60[b] | 1.34[c] | 1.54[b] | 1.87[a] |
| Annual daily gain (birth to weaning)[1] | 1.74[b] | 1.51[c] | 1.80[b] | 1.93[a] |
| Adjusted 240-day weight[1,4] | 537[b] | 475[c] | 550[b] | 588[a] |
| Calf gain per acre, lb | 365 | 347 | 374 | 406 |

[a,b,c]Means in the same cow superscripted with different letters are different ($P < .05$).

[1]These means are least-squares means.

[2]Spring average daily gain from birth to approximately July 1.

[3]Summer average daily gain from approximately July 1 to Nov. 1.

[4]Adjusted 240-day weight was adjusted to remove variation due to differences in weaning age, sex of calf and age of dam (age of dam coded 2, 3, 4, 5, 6-10, 11, 12, 13, 14).

Table 10. Effects of method and frequency of renovation of fescue pastures on individual cow performance (1980-1982)

| Variable | Method and frequency of renovation | | | |
|---|---|---|---|---|
| | 3 to 4 Year intervals | | Annual | |
| | Zebra | Minimum tillage | Minimum tillage | Minimum tillage |
| Fall nitrogen, lb/A | 0 | 0 | 0 | 75 |
| Number of test cows (3 years) | 36 | 36 | 36 | 36 |
| Days on pasture, summer | 225 | 225 | 225 | 225 |
| Days on pasture, winter | 135 | 135 | 135 | 135 |
| Average weight and gain, lb | | | | |
| Initial weight[1] | 1024 | 983 | 1022 | 1086 |
| Final weight | 1065 | 1022 | 1066 | 1131 |
| Winter gain[2,3,6] | -19[c] | 68[a] | 7[b] | 16[b] |
| Spring gain[4,6] | 33[a] | -14[b] | 22[a] | -12[b] |
| Summer gain[5,6] | 51[a,b] | 23[c] | 34[b] | 63[a] |
| Annual gain (birth to weaning)[6] | 70 | 56 | 57 | 60 |
| Percent cows calved | 81 | 82 | 81 | 81 |

[a,b,c]Means in the same row superscripted with different letters are different ($P < .05$).

[1]Initial weight not available for Fall 1979, experiment started in spring.

[2]Winter gains contain data for 1981 and 1982 only.

[3]Winter gains from approximately Nov. 15 of the preceding year to approximately Apr. 1 of the current year.

[4]Spring gain from approximately Apr. 1 to July 1.

[5]Summer gain from approximately July 1 to Nov. 1.

[6]These means are least-squares means.

Table 11. Effects of method and frequency of renovation of fescue pastures on pasture productivity (1980-1982)

| Variable | Method and frequency of renovation | | | |
|---|---|---|---|---|
| | 3 to 4 Year intervals | | Annual | |
| | Zebra | Minimum tillage | Minimum tillage | Minimum tillage |
| Fall nitrogen, lb/A | 0 | 0 | 0 | 75 |
| Grazing days (spring-summer) | 153 | 164 | 154 | 156 |
| Average spring and summer stocking rate, cows | .68 | .73 | .68 | .69 |
| Winter grazing days | 67.5 | 67.5 | 67.5 | 67.5 |
| Average winter stocking rate, cows | .6 | .6 | .6 | .6 |
| Winter cow gain (Nov. 15-Apr. 1), lb | -11.4 | -10.2 | 15.0 | -8.3 |
| Summer cow gain (July 1-Nov. 1), lb | 34.7 | 16.8 | 23.1 | 43.5 |
| Annual cow gain[1], lb | 46.2 | 40.3 | 37.6 | 40.2 |

[1]Winter, spring, and summer cow gains per acre will not add to total cow gains per acre because stocking rates per acre were different in the winter period and because only 1981 and 1982 years were used to figure total gain per cow per acre.

renovated every 3 to 4 years were similar to those of calves grazing pastures thinned by close grazing in the spring and renovated annually. This indicates that thinning of the fescue stand by close grazing in the early spring and renovation every 3 to 4 years may not be sufficient to maintain a desirable level of legumes in fescue sods.

Summer average daily gains of calves grazing fescue renovated annually was higher ($P < .0001$) than that of calves grazing fescue renovated every 3 to 4 years. Calves grazing fescue pastures that were chemically thinned and renovated every 3 to 4 years gained more ($P < .01$) than did calves grazing fescue thinned by grazing and renovated every 3 to 4 years. Calves grazing fescue pastures that were thinned by grazing and renovated annually supported lower ($P < .001$) calf gains that did similar pastures fertilized with 75 pounds of nitrogen per acre each fall. This indicates a residual effect of nitrogen fertilization on spring fescue.

Fescue pastures renovated annually produced higher ($P < .0001$) total calf gains than fescue pastures renovated every 3 to 4 years. Calves grazing chemically thinned fescue pastures renovated at 3 to 4 year intervals gained more ($P < .0001$) from birth to weaning than did calves grazing fescue pastures thinned by close grazing and renovated at 3 to 4 year intervals. Calves grazing fescue pastures renovated annually without fall nitrogen gained less ($P < .01$) during summer than did calves grazing fescue pastures that were renovated each spring and fertilized with 75 pounds of nitrogen each fall.

The adjusted 240-day weights were greater ($P < .05$) of calves grazing annually renovated fescue compared to calves grazing fescue renovated every 3 to 4 years, and calves grazing chemically thinned fescue pastures renovated every 3 to 4 years had higher adjusted 240-day weights than calves grazing fescue pastures thinned by close grazing and renovated every 3 to 4 years. Annually renovated pastures with no fall nitrogen fertilizer produced calves that had lighter ($P < .01$) adjusted 240-day weights than those grazing pastures renovated annually and receiving 75 pounds of nitrogen fertilizer in the early fall. Annual renovation of fescue pastures plus 75 pounds of nitrogen fertilizer applied in the fall produced heavier calves than any of the other renovation procedures.

Total calf gains per acre were greatest on the annually renovated fescue pasture fertilized with nitrogen (406 pounds per acre). Annually renovated fescue with no fall nitrogen produced 374 pounds of calf gain per acre and fescue chemically thinned and renovated every 3 to 4 years produced 365 pounds of calf gain per acre. Fescue pastures with the stand thinned by close grazing and renovated every 3 to 4 years produced the lowest calf gain per acre (347 pounds).

Cow performance during Phase IV is presented in Table 10. Winter gains of cows grazing fescue pastures renovated annually were similar to those of cows supported by pastures renovated every 3 to 4 years. Cows allotted to pastures in which the fescue was thinned by grazing and renovated every 3 to 4 years were lighter in weight in

the fall of 1980 than cows allotted to the other treatments. Compensatory gains made by these cows and subsequent higher loss of calving could result in the differences observed in this study. It should be noted that, with the exception of the pastures that were nitrated each fall, cows in this study were primarily dependent on hay during the winter, and differences in winter gain were probably due to differential hay intake.

Summer cow gains were higher ($P < .07$) on annually renovated pastures than on pastures renovated every 3 to 4 years and summer gains were higher ($P < .01$) also in cows grazing the chemically thinned fescue pastures renovated every 3 to 4 years than in those grazing fescue pastures thinned by close grazing and renovated at the same intervals. Annual renovation of fescue pastures plus nitrogen fertilizer in the fall resulted in higher ($P < .001$) summer gains than similar fescue pastures without fall nitrogen fertilizer.

The method and frequency of renovating fescue pastures did not affect total cow gain (Table 11) and it can be concluded that cow gains are not affected by pasture renovation systems to the same degree as are calf gains. When some legumes are present, cows will perform well; and they do not respond to additional legumes in fescue sod to the extent that calves do. These results suggest that cows gain in the earlier trials were affected more by spring nitrogen than by the low percentage of legumes in some pastures.

# V. DISCUSSION

Results from the first experiment in this series indicate little difference between the Kentucky 31 and Kenwell cultivars of tall fescue as the basic grass in pastures for beef cows. Both cow and calf performance supported by the two cultivars were similar. One of the critical characteristics of a fescue cultivar is its compatibility with legumes when seeded in mixtures. Neither cultivar exhibited superiority with respect to this trait.

Although conception rate is cows grazing Kentucky 31 pastures was higher than in those grazing Kenwell pastures, both rates were within the range reported in other studies. The conception rate of cows grazing Kentucky 31 in this study was similar to the 92% rates reported by Anderson and Safley (1967) and Smith et al. (1975) in cows grazing renovated Kentucky 31 fescue. The 80% conception rate of cows grazing Kenwell pastures was lower than that of cows grazing Kentucky 31, and could be a true cultivar difference or could be an artifact resulting from bull management necessitated by the design of this experiment.

Nitrogen fertilization of fescue pastures in the spring resulted in increased spring-summer forage production (measured in terms of grazing days per acre). When fescue pastures were fertilized with 75 pounds nitrogen per acre, carrying capacity was increased 42% over nonnitrated pastures. When the spring nitrogen application was increased to 150 pounds per acre, carrying capacity per acre was

increased only 19% over that of pastures fertilized with 75 pounds of nitrogen per acre.

When nitrogen fertilization was increased from 0 to 75 pounds per acre, summer calf gains were reduced 18%; but, since spring gains were slightly higher in calves grazing the nitrated pastures than in those grazing nonnitrated pastures, 240-day weight was similar in the two groups. However, the increased stocking rate resulted in a 40% increase in beef production per acre.

When nitrogen fertilization was increased from 75 to 150 pounds per acre, spring calf gains decreased 8.7%, summer calf gains decreased 13.6%, and 240-day weight increased 6.2%. However, in this study, the increased stocking rate resulted also in an increase of 11.6% in calf gain per acre. These increases in calf gains per acre may not be high enough to justify the cost of the high rate of nitrogen and the extra cost associated with maintaining additional cows and calves to harvest the increased forage production.

Fall nitrogen fertilization resulted in increased stockpiled forage for fall and winter grazing. This practice delayed the need to begin winter hay feeding, reduced the amount of hay required during the winter, and appears to be a feasible practice to extend the productivity of fescue pastures.

The absolute magnitude of the effects of nitrogen fertilization on cow conception rate cannot be estimated from these studies. However, the evidence is conclusive that 75 pounds or more nitrogen per acre applied in the spring will result in a reduction in fall pregnancy

rate of between 10 to 20 percentage units and will have a significant economic impact on a cow-calf operation. These differences could be due to differences in embryonic death following equal conception rates in cows grazing the renovated or spring nitrated fescue pastures. Fall nitrogen fertilization did not affect conception rate when a favorable grass-legume ratio was reestablished the following spring.

When nitrogen fertilization of fescue pastures, in Phase II, was increased from 75 pounds (in both spring and fall) to 150 pounds per acre, individual summer calf gain and winter cow gain was decreased. In addition, the higher nitrogen rates had a greater depressing effect on cow conception than when 75 pounds per acre was used. The increased nitrogen fertilization tended to complicate overall animal management as well as reduce individual cow and calf performance. The only positive result of this increased nitrogen fertilization was increased feed production during the entire year. This increased feed production dictated that additional cows and calves be used to harvest the extra forage, and this increased number of cows would be of economic importance to a cow-calf producer.

Of greater importance is the fact that by annual renovation of fescue pastures and the application of 75 pounds of nitrogen per acre to those pastures each fall the quality of spring forage and the amount of stockpile forage for winter feed produced by a fescue pasture can be increased. There are several factors which influence the success of this system. They are:

1. Renovation must be accomplished with minimum cost. Annual renovation by thinning the fescue stand by close grazing in February and introducing ladino clover and lespedeza seed by broadcasting or with a drill set to penetrate the soil to a shallow depth is economical and satisfactory.
2. Annual renovation should be done in such a way that the cows can graze the early spring fescue growth to reduce its competition with the legume seedlings.
3. During mid-summer the pasture should be grazed closely (June 15 to July 15) in order to reduce the competition between spring stockpiled fescue and the lespedeza. This requires rotational grazing which was accomplished in this study by partitioning each pasture with a two-strand electric fence.
4. Fall nitrogen should be applied in August or early September following removal of any accumulated fescue forage by grazing. Previous work by Fribourg et al. (1978) showed that stockpiled fescue quality was reduced by starting the stockpiling process earlier than mid-August.
5. In this study, cows remained on the pastures throughout the entire year. Renovation and nitrogen fertilization were accomplished by rotating cows between the two partitions of each pasture.

Some of the difference in response of pastures to renovation and nitrogen fertilization observed in Phase II as compared to that

observed in Phase III may be explained by rainfall difference (Table 12). The amount and distribution of rainfall is critical to the response of fescue to nitrogen fertilization, in Phase II the precipitation during April-May was generally below normal, and during Phase III precipitation during these months was high. However, during the fall, precipitation was about normal. During Phase IV of this study, the distribution of the rainfall tended to favor spring renovation.

The results of this study tend to support the use of nitrogen for fall stockpiling of fescue for winter feed.

## VI. CONCLUSIONS

Several conclusive facts and some obvious trends involving the management of fescue pastures for beef cows can be gleaned from these experiments.

High rates of nitrogen (75 pounds or more per acre) applied to fescue pastures in the spring increases pasture production (forage yield or animal grazing days), reduces conception rate, increases total beef production per acre, reduces individual calf and calf summer gains, and tends to increase expression of signs associated with the summer (fescue) syndrome.

Table 12. Precipitation at Highland Rim Experiment Station (1970-1983)

| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | Ten year average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 0.85 | 2.99 | 7.90 | 2.82 | 8.69 | 5.75 | 5.75 | 1.80 | 5.13 | 6.00 | 2.27 | 1.57 | 5.88 | 2.06 | 4.81 |
| February | 5.57 | 4.21 | 3.80 | 2.77 | 2.53 | 4.98 | 3.34 | 3.56 | .95 | 4.00 | 2.04 | 4.06 | 4.07 | 1.89 | 4.61 |
| March | 3.91 | 2.38 | 4.67 | 8.47 | 4.06 | 15.70 | 7.94 | 5.83 | 3.31 | 5.25 | 6.34 | 3.52 | 1.95 | 3.86 | 4.84 |
| April | 5.45 | 2.64 | 3.37 | 6.99 | 3.63 | 2.44 | 1.25 | 5.33 | 3.17 | 10.87 | 2.68 | 4.54 | 6.75 | 8.43 | 4.27 |
| May | 3.04 | 4.48 | 4.32 | 7.04 | 8.94 | 5.66 | 5.50 | 2.41 | 4.95 | 6.16 | 4.63 | 4.34 | 4.73 | 12.71 | 4.24 |
| June | 4.53 | 4.83 | 1.31 | 2.55 | 8.67 | 2.43 | 6.67 | 6.27 | 2.33 | 2.65 | 3.72 | 9.92 | 2.19 | 4.11 | 3.42 |
| July | 2.44 | 6.07 | 5.35 | 6.98 | 3.28 | 1.08 | 5.56 | 6.01 | 5.93 | 7.83 | 2.24 | 5.22 | 1.61 | 2.92 | 3.68 |
| August | 3.22 | 4.95 | 2.37 | 3.54 | 6.55 | 4.19 | 1.31 | 2.16 | 5.94 | 8.31 | 1.65 | 2.31 | 3.68 | 1.10 | 3.20 |
| September | 2.41 | 2.07 | 4.38 | 1.08 | 8.47 | 7.09 | 2.45 | 4.90 | .40 | 10.10 | 2.23 | 4.97 | 4.39 | .95 | 2.75 |
| October | 4.36 | 0.59 | 4.00 | 3.01 | 1.50 | 4.42 | 4.78 | 4.53 | 2.82 | 3.12 | 1.38 | 4.69 | 1.15 | | 2.69 |
| November | 2.52 | 1.61 | 6.28 | 10.01 | 4.43 | 2.41 | .96 | 5.40 | 4.48 | 7.56 | 3.22 | 1.83 | 2.93 | | 3.99 |
| December | 5.04 | 4.05 | 8.73 | 3.17 | 3.33 | 4.94 | 1.34 | 5.67 | 11.74 | 4.78 | 1.49 | 3.63 | 6.02 | | 4.48 |
| Total | 43.34 | 40.87 | 56.48 | 58.43 | 64.08 | 61.09 | 46.85 | 53.87 | 51.15 | 76.63 | 33.89 | 50.60 | 45.35 | | 46.98 |
| Monthly Average | 3.611 | 3.405 | 4.706 | 4.869 | 5.34 | 5.09 | 3.90 | 4.49 | 4.26 | 6.38 | 2.82 | 4.21 | 3.77 | | |

# CHAPTER IV

## SUMMARY

Tall fescue (Festuca arundinacea Schreb.) is the most important pasture grass used as a base for beef pastures in the upper Mid-South because of its ease of establishment, hardiness, and response to nitrogen fertilizer and (or) renovation with legumes. However, in spite of its excellent agronomic characteristics, tall fescue has been criticized throughtout its region due to poor performance of the animals consuming this forage. Several researchers have discussed management practices which can be used to improve animal performance and increase the amount of beef produced per acre.

Eight 10-acre pastures, stocked with approximately 5 cow-calf units (.5 units per acre), were used in this study to: (1) compare fescue cultivars (Kentucky 31 and Kenwell), (2) study the effects of renovation and nitrogen fertilization on animal performance and pasture productivity, (3) compare renovation methods, and (4) compare extensive and intensive pasture management.

Kentucky 31 and Kenwell cultivars supported similar animal gains; renovation of tall fescue pastures with legumes in the early spring increased animal gains; cow and calf condition scores were higher for renovated pastures; spring fertilization of fescue sod with nitrogen reduced calving percentage; the addition of nitrogen fertilizer to tall fescue pastures during the spring reduced

individual cow and calf gains; feed production was greater from pastures nitrated in the spring and fall; total beef produced per acre was greater on nitrated pastures. The best combination of management practices to increase fall feed production and spring-summer forage quality were fall nitrogen fertilization (75 pounds per acre) followed by spring renovation with ladino clover and lespedeza.

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# VITA

Jesse Ray Ford was born in Lynchburg, Virginia, on November 2, 1944. He attended elementary schools in Lynchburg and was graduated from Rustburg High School, Rustburg, Virginia, in 1963. The following September he entered Furrum Jr. College, Furrum, Virginia, and in September 1964 he entered The University of Tennessee, Knoxville. In the spring of 1968 he graduated from The University of Tennessee, Knoxville, with a B.S. degree in Animal Science. In the winter of 1969 he again entered The University of Tennessee, Knoxville, and received a M.S. degree in Animal Science in the winter of 1974.

He worked as a county agent in Amherst County, Virginia, from the fall of 1970 to the summer of 1977 at which time he was self-employed as a full-time farmer. In the fall of 1979 he went back to work for the Virginia Cooperative Extension Service as a state livestock specialist. In the fall of 1980 he again entered The University of Tennessee, Knoxville, and began his study toward a Doctor of Philosophy degree. He received the Doctor of Philosophy degree with a major in Animal Breeding in March 1984. He is a member of the Block and Bridle Club, Alpha Zeta, and Gamma Sigma Delta.

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