8-1979

Nutritive value for yearling beef steers of pastures of orchardgrass-clover, fescue and midland bermudagrass alone or with fescue or legumes

Terry Lee Zachary

To the Graduate Council:

I am submitting herewith a thesis written by Terry Lee Zachary entitled "Nutritive value for yearling beef steers of pastures of orchardgrass-clover, fescue and midland bermudagrass alone or with fescue or legumes." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.

Karl Barth, Major Professor

We have read this thesis and recommend its acceptance:

H. A. Fribourg, J. B. McLaren

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

To the Graduate Council:

I am submitting herewith a thesis written by Terry Lee Zachary entitled "Nutritive Value for Yearling Beef Steers of Pastures of Orchardgrass-Clover, Fescue and Midland Bermudagrass Alone or With Fescue or Legumes." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.

Karl Barth, Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:

Vice Chancellor
Graduate Studies and Research

NUTRITIVE VALUE FOR YEARLING BEEF STEERS OF PASTURES OF ORCHARDGRASS-CLOVER, FESCUE AND MIDLAND BERMUDAGRASS ALONE OR WITH FESCUE OR LEGUMES

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Terry Lee Zachary

August 1979

ACKNOWLEDGMENTS

The author is thankful for the chance to express his gratitude to Dr. K. M. Barth, his major professor, whose guidance and supervision made the entire graduate study a more meaningful experience.

The author is indebted to those who served on his graduate committee, Dr. H. A. Fribourg and Dr. J. B. McLaren, for their assistance in the evaluation of the experimental data and their review of this manuscript. He is also grateful to Dr. H. A. Fribourg and staff of the Department of Plant and Soil Science for the nitrogen analysis of the forage samples.

The author is appreciative to Mr. James Bryan and other Ames Plantation personnel for providing the pastures and beef cattle along with the harvesting of the forage samples.

He would like to thank Ann Lacava and Patsy Bivens for the editing and typing of this manuscript.

Others who deserve recognition for making this period of study possible are:

Ms. Brenda Bowling and Ms. Bobbie Wayland for help with the preparation of this manuscript;

Mr. M. E. Fryer and Mr. R. A. Munsinger for their assistance in conducting the in vitro dry matter digestibility studies;

The author's parents, Mr. and Mrs. Kit Zachary, whose constant encouragement and aid will never be forgotten;

The author's wife, Rebecca Jane, for her sacrifice, faith and loyalty throughout his graduate study.

ABSTRACT

Midland bermudagrass pastures consisting of Midland bermudagrass or Midland in combination with either tall fescue or legumes were compared to each other and to orchardgrass-clover or tall fescue pastures. The cage-and-strip method was used to determine forage consumption from the beginning of May until the beginning of September during 1975, 1976 and 1977. Yearling beef steers acquired from fall feeder calf sales and weighing an average of approximately 215 kg were used in a put-and-take grazing system. Tester steers were weighed at about 21-day intervals to determine rate of gain. All forage samples were assayed for total N and in vitro digestible dry matter (IVDDM). Estimated total digestible nutrients (ETDN) was calculated from IVDDM.

Three years of forage composition and intake data were reduced to polynomial equations describing the regression of ETDN and crude protein (CP) content and the intake of ETDN and CP, on elapsed days of grazing. The regression equations were used to generate predicted percentages of ETDN and CP and consumption of ETDN and CP at monthly intervals beginning on May 1 and extending to September 1.

The available forage of all the pastures decreased in ETDN content during the month of May with Mid + N and Mid + legumes forage exhibiting this decline throughout the grazing season. The %ETDN in available Mid + fescue, fescue and OG + clover changed little from June until pasture grazing was terminated.

Available Mid + legumes was the only pasture forage to increase in %CP from the beginning of the season, while all other pastures decreased in %CP. However, the decline of %CP in available Mid + N, Mid + fescue, fescue and OG + clover ended during early summer and began to increase. Only the pastures containing Midland forage decreased in CP content in late summer.

Consumed Mid + N, Mid + legumes, Mid + fescue and OG + clover forage decreased in ETDN content during May, with Mid + N and Mid + legumes continuing this trend throughout the season. Consumed Mid + fescue and OG + clover increased in %ETDN from July 1 until the animals were taken off. Fescue varied little in the ETDN content of consumed forage.

The %CP in consumed Mid + N and Mid + legumes decreased at about the same rate from May 1 to September 1. Consumed Mid + fescue, fescue and OG + clover increased in %CP throughout May. The CP content of consumed Mid + fescue and OG + clover were decreasing at season's end, while consumed fescue forage increased in %CP for the entire season.

Animals grazing Mid + fescue and Mid + legumes decreased their DM consumption/day for the entire season with Mid + legumes being consumed at a higher level in the beginning. Only in late spring and late August was Mid + N consumed at a greater level than either of the other two Midland treatments. Fescue DM consumption decreased steadily from May 1 to August 1, while OG + clover forage consumption increased from mid-May until late June preceded by a dramatic decrease.

Steer ETDN consumption/day decreased continuously from the beginning for all treatments except OG + clover which increased slowly from mid-May to mid-June followed by a significant decrease through July.

Fescue pastures allowed steers to consume levels of CP that were comparable to Mid + legumes without as rapid a decline, while steers on OG + clover increased CP consumption steadily until July when consumption levels decreased drastically.

Intake above maintenance data followed the same trends as consumption data.

Steer ETDN consumption per unit metabolic weight (gm/day) decreased throughout the season for all treatments.

Steers grazing Mid + legumes, Mid + fescue and fescue decreased their CP intake per unit metabolic weight by 25.3, 5 and 11.2 gm/day, respectively, over the course of the grazing season. Mid + N and OG + clover provided more CP consumption in late spring (16.4 gm/day) and early summer (17.8 gm/day, respectively) than any other time.

ETDN composition of available forage appeared to be more related to ADG than did CP composition. ADG did not appear to be related to the composition of consumed forage except for Mid + N pastures that demonstrated a rapid decline in both variables. ADG seemed to be most closely related to the consumption of ETDN and less related to CP and DM consumption.

TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
II.	REVIEW OF LITERATURE	3
	Effect of Nitrogen Fertilization on Forage of Perennial Pastures	5
	Effect on Total Forage Production	5
	Effect on Nutritive Value of Available Forage	5
	Effect on Nutritive Value of Consumed Forage	6
	Establishment of Legumes in Bermudagrass and Other Perennial Sods	8
	Effect on Total Forage Production	8
	Effect on Animal Performance	10
	The Introduction of Annual and Perennial Grasses in Bermudagrass Sod	11
	Effect on Total Forage Production	12
	Effect on Animal Performance	13
III.	EXPERIMENTAL PROCEDURE	15
	Experimental Pastures	15
	Sample Collection	17
	Grazing Management	17
	Experimental Animals	18
	Digestibility and Crude Protein Analyses	19
	In Vitro Digestibility of Forage	19
	Nitrogen Content of Forage	19
	Statistical Analysis	21
IV.	RESULTS AND DISCUSSION	23
	Composition of Available Forage	23
	Estimated Total Digestible Nutrient Content	23
	Crude Protein Content	29
	Composition of Consumed Forage	34
	Estimated Total Digestible Nutrients	34
	Crude Protein Content	38
	Amount of Intake	44
	Dry Matter	44
	Estimated Total Digestible Nutrients	48
	Crude Protein	54
	Amount of Intake above Maintenance	59
	Estimated Total Digestible Nutrients	59
	Crude Protein	64

CHAPTER PAGE

Amount of Intake per Unit Metabolic Weight 68
Estimated Total Digestible Nutrients 68
Crude Protein 68
Average Daily Gain 70
Comparison of ADG and Composition of Consumed Forage . . 70
Comparison between ADG and Amount of Consumed Forage . . 72

V. SUMMARY 73

BIBLIOGRAPHY 76

VITA 81

LIST OF TABLES

TABLE PAGE

1. Experimental Setup 16

2. Predicted Monthly Changes in Composition of Available Pasture Forage 24

3. Predicted Monthly Changes in Composition of Consumed Pasture Forage 35

4. Predicted Monthly Changes in Nutrient Consumption 46

5. Predicted Monthly Changes in Consumption above Maintenance . 63

6. Predicted Monthly Changes in Consumption per Unit Metabolic Weight 69

7. Predicted Monthly Average Daily Gain 71

LIST OF FIGURES

FIGURE		PAGE
1.	ETDN Content of Available Forage from Midland Bermudagrass Fertilized with Nitrogen or Overseeded with Either Legumes or Tall Fescue	25
2.	ETDN Content of Available Forage from Midland Bermudagrass Overseeded with Tall Fescue and Tall Fescue Alone	27
3.	ETDN Content of Available Forage from Midland Bermudagrass Overseeded with Legumes and Orchardgrass Plus Clover	28
4.	CP Content of Available Forage from Midland Bermudagrass Fertilized with Nitrogen or Overseeded with Either Legumes or Tall Fescue	30
5.	CP Content of Available Forage from Midland Bermudagrass Overseeded with Tall Fescue and Tall Fescue Alone	32
6.	CP Content of Available Forage from Midland Bermudagrass Overseeded with Legumes and Orchardgrass Plus Clover	33
7.	ETDN Content of Consumed Forage from Midland Bermudagrass Fertilized with Nitrogen or Overseeded with Either Legumes or Tall Fescue	36
8.	ETDN Content of Consumed Forage from Midland Bermudagrass Overseeded with Tall Fescue and Tall Fescue Alone	37
9.	ETDN Content of Consumed Forage from Midland Bermudagrass Overseeded with Legumes and Orchardgrass Plus Cover	39
10.	CP Content of Consumed Forage from Midland Bermudagrass Fertilized with Nitrogen or Overseeded with Either Legumes or Tall Fescue	40
11.	CP Content of Consumed Forage from Midland Bermudagrass Overseeded with Tall Fescue and Tall Fescue Alone	42
12.	CP Content of Consumed Forage from Midland Bermudagrass Overseeded with Legumes and Orchardgrass Plus Clover	43
13.	DM Consumption from Midland Bermudagrass Fertilized with Nitrogen or Overseeded with Either Legumes or Tall Fescue .	45
14.	DM Consumption from Midland Bermudagrass Overseeded with Tall Fescue and Tall Fescue Alone	47

FIGURE PAGE

15. DM Consumption from Midland Bermudagrass Overseeded with Legumes and Orchardgrass Plus Clover 49

16. ETDN Consumption from Midland Bermudagrass Fertilized with Nitrogen or Overseeded with Either Legumes or Tall Fescue . 50

17. ETDN Consumption from Midland Bermudagrass Overseeded with Tall Fescue and Tall Fescue Alone 52

18. ETDN Consumption from Midland Bermudagrass Overseeded with Legumes and Orchardgrass Plus Clover 53

19. CP Consumption from Midland Bermudagrass Fertilized with Nitrogen or Overseeded with Either Legumes or Tall Fescue . 55

20. CP Consumption from Midland Bermudagrass Overseeded with Tall Fescue and Tall Fescue Alone 57

21. CP Consumption from Midland Bermudagrass Overseeded with Legumes and Orchardgrass Plus Clover 58

22. ETDN Intake above Maintenance from Midland Bermudagrass Fertilized with Nitrogen and Overseeded with Either Legumes or Tall Fescue 60

23. ETDN Intake above Maintenance from Midland Bermudagrass Overseeded with Tall Fescue and Tall Fescue Alone 61

24. ETDN Intake above Maintenance from Midland Bermudagrass Overseeded with Legumes and Orchardgrass Plus Clover 62

25. CP Intake above Maintenance from Midland Bermudagrass Fertilized with Nitrogen or Overseeded with Either Legumes or Tall Fescue 65

26. CP Intake above Maintenance from Midland Bermudagrass Overseeded with Tall Fescue and Tall Fescue Alone 66

27. CP Intake above Maintenance from Midland Bermudagrass Overseeded with Legumes and Orchardgrass Plus Clover 67

CHAPTER I

INTRODUCTION

Until recently, the American people had become accustomed to large grain surpluses which were the basis of inexpensive cattle finishing rations. Consequently, beef cattle populations grew to the level of market saturation just at the time when foreign grain sales rose drastically. Surpluses of beef became almost nonexistent and as a result, cattlemen have been in the liquidation phase of the most financially destructive cattle cycle since 1895. Grain stocks are now at their highest point in four years but export demand is still high at a time when U.S. balance of payments dictate grain exports.

In contrast, an optimistic view should be taken toward beef production in the Southeast because of its advantage over most of the nation in the length of pasture season. For years, a high percentage of the weaned feeder calves from the Southeast were shipped directly to the feedlots of the Midwest and Southwest for finishing. It was thought that the Southeast was too hot and humid with high rainfall for economic beef production. The cost of shipping grain to this area was also a factor when the conversion rate of grain to meat (9 to 1) was considered.

Many researchers are now advocating that these Southeastern weaned feeder calves be carried on good quality pastures to maximum growth and frame development, and then fed grain in confinement for 100 to 120 days. This could result in a lifetime conversion of two units of grain to one unit of meat.

The quality and quantity of the forage are both essential aspects in a successful beef cattle grazing program. In Tennessee, a large portion of the five million acres of permanent pastures are in cool season grasses and legumes. These grasslands offer an abundance of lush growth in the spring, early summer and fall, but they tend to become dormant in the summer when temperatures are high and moisture is not abundant. Warm season perennials, such as Midland bermudagrass (Cynodon dactylon {L.} Pers.), can be integrated into a grazing program to provide an abundance of medium-quality forage in midsummer, provided the proper grazing management and adequate fertilization can be used.

The objectives of this experiment were to measure the productive capacity and relative nutritive value of Midland bermudagrass grown alone or in combination with tall fescue or legumes throughout the growing season and to compare these combinations to fescue grown alone and to a mixture of orchardgrass and clover. These pastures were grazed by beef steers and crude protein composition and digestibility of available and consumed forages were related to animal performance.

CHAPTER II

REVIEW OF LITERATURE

Bermudagrass (Cynodon dactylon {L.} Pers.) can be found throughout the tropical and subtropical regions of the world. Due to the diversity in form and type that exist in these regions, it is now thought that bermudagrass originated in Africa rather than India, where the species fails to exhibit this same diversity (Burton, 1966). The introduction of bermudagrass into the United States has been documented as early as 1807, and since most Southeastern farmers of that period were interested mainly in growing corn and cotton, common bermudagrass was considered to be only a prolific weed. However, a few pioneer agriculturists had recognized the potential value of this grass for pasture.

"Coastal" bermudagrass was developed at the Georgia Coastal Plain Experiment Station by G. W. Burton in 1938 as an F_1 hybrid obtained from seed produced from a common bermudagrass, found in Tifton, Georgia, interplanted with two tall-growing introductions of bermudagrass from South Africa. Since that time and until recently, Coastal bermudagrass has become the standard by which common bermudagrass was measured. When compared with common bermudagrass, Coastal has longer and larger leaves, stems and rhizomes, making it more suitable for hay. Coastal, for all practical purposes, is sterile and if established on or near cropland, produces no viable seed to contaminate the soil. Coastal produces far more forage than common bermudagrass, and it is resistant to foliage diseases and root knot nematode (Fribourg, 1963).

Another bermudagrass hybrid that is gaining popularity as a forage crop in Florida and the southern Gulf coast states is

"Coastcross-1." It is an F_1 hybrid of Coastal and "Kenya 56 #14" bermudagrass, developed also by G. W. Burton and associates. A four-year grazing study in the Gulf Coast area by Utley et al. (1974) verified previous experimentation that Coastcross-1 was superior to Coastal bermudagrass in average daily gain when grazed by beef cattle (.49 and .68 kg/day, respectively) and average beef production per ha (372 and 527 kg/ha/year, respectively). Coastal, however, is more winter hardy and produces up to 35% more dry matter per season than Coastcross-1 (Utley et al., 1974).

At the Georgia Coastal Plain Experiment Station in 1942, a cross was made between Coastal and a local strain of cold-hardy common bermudagrass from Indiana. This F_1 hybrid was eventually designated as "Midland," and although inferior to Coastal in disease resistance and yield in the Coastal Plains states, it is far more winter hardy and can be successfully grown where Coastal is highly susceptible to winter kill. Like Coastal, it is sterile and must be propagated vegetatively. Kresge and Decker (1965) reported that Midland was cold resistant to about 39° 15' latitude, thus including Maryland and the southern regions of Ohio, Indiana, and Illinois in its range of adaptation. Midland rhizomes tend to be long and straight and do not form a dense mat below the ground surface as do common types (Harlan et al., 1954). This quality may make it a good choice as a companion crop for legumes and other grass species. Also, Midland emerges from dormancy two to three weeks earlier in the spring than common and three to five weeks earlier than Coastal (Fribourg, 1963).

Effect of Nitrogen Fertilization on Forage of Perennial Pastures

Effect on Total Forage Production

It has been shown that bermudagrass yields up to 15,000 kg of DM/ha when fertilized with 900 kg of N/ha, if there is an adequate moisture supply (Burton et al., 1963). Decker et al. (1971) reported Midland yields of over 24,500 kg/ha of low quality hay that could probably be used only as a maintenance ration for wintering beef cows. Coastal bermudagrass produced approximately twice as much dry matter as Ky 31 tall fescue (*Festuca arundinacea* L.) at each increment of N fertilization (112, 224, 448 and 898 kg N/ha), with similar relationship noted for crude protein yield (Hallock et al., 1965).

Severe thinning of tall fescue stands became common on pastures fertilized with 448 and 898 kg/ha of N, whereas excellent stands remained throughout the study on pastures fertilized at the 224 kg/ha with dry matter yields of approximately 2090 kg (Hallock et al., 1966). The higher rates of N fertilization were associated with decreased hot-water soluble carbohydrate contents of the fescue stubble above 224 kg/ha of nitrogen application. It was postulated that high rates of N on freshly defoliated cool season grasses during hot weather may increase respiration and regrowth demands beyond the photosynthetic capacity of some plants under such conditions.

Effect on Nutritive Value of Available Forage

Although impressive dry matter yields were obtained from Midland pastures with heavier N applications, Telford et al. (1975) observed that higher fertilization levels increased crude protein (CP) content but did not consistently affect the energy yielding constituents of Midland forage. However, Fribourg et al. (1971) reported that in vitro dry matter digestibility (IVDMD) increased from 2 to 6.5 percentage units when N applications to Midland bermudagrass were increased from 133 to 400 kg/ha. Fribourg et al. (1978) later found that Midland pastures fertilized with 224 or 448 kg N/ha/year had slightly higher IVDMD (3.4%) in May and early June than Midland fertilized with 112 kg N/ha/year. Likewise, Midland pastures fertilized with 112 kg N/ha/year were 5 to 8% greater in IVDMD in spring than Midland pastures receiving no N. These small differences disappeared by mid-July.

Carver (1975) reported an increase in CP content with increasing levels of N fertilization throughout the grazing season when Midland pastures were fertilized with 112, 224 or 448 kg N/ha/year. At the beginning of the grazing season, the CP content of available forage was quite high (19, 19 and 24%, respectively). There was a rapid decrease until early July, followed by a much slower decrease during the remainder of the season. After mid-July, it became apparent that Midland fertilized with 112 kg N/ha/year was deficient in CP during the last 80 days of the season. It was thought that this rapid decrease in CP content early in the growing season could have been partially slowed if there had been three applications of approximately 56 kg N/ha.

Effect on Nutritive Value of Consumed Forage

Carver et al. (1978) found Midland bermudagrass fertilized with 448 kg N/ha/year contained estimated total digestible nutrients (ETDN) of 68% at the beginning of the grazing season in May. However, ETDN decreased quickly to about 45% by mid-July. N fertilization had little effect on ETDN content of consumed Midland forage until the end of August, at which time the consumed forage contained 50% ETDN, 4 to 5 percentage units less than on July 20. After mid-August, Midland pastures fertilized with less N contained lower percentage ETDN; it was thought that higher N fertilization rates could possibly maintain ETDN content at a higher level toward the end of the grazing season.

Carver also demonstrated that Midland pastures fertilized with at least 112 kg N/ha/year could satisfy the TDN requirements of a 300 kg steer gaining .5 kg/day (57% of the ration or 3.6 kg of TDN/day) for the first 60 days of the grazing season only. Midland without N fertilization came close to meeting the TDN requirement for the first 40 days only. Steers consumed more ETDN from Midland pastures fertilized with 112 kg N/ha/year than from the same pastures not fertilized or fertilized with either 224 or 448 kg N/ha/year.

Each increase in the level of N fertilization resulted in higher CP content in the consumed forage throughout the grazing season (Carver, 1975). This was thought to be due to the less physiologically mature state that is encouraged when N fertilization is increased and grazing pressure is maintained high enough to prevent accumulations of senescent leaves and stems. When Midland pastures were fertilized with 448 kg N/ha/year, the CP content of the consumed forage decreased from 29% at the beginning of the grazing season until mid-June, leveled off at about 20% and then declined again about August 1.

Establishment of Legumes in Bermudagrass and Other Perennial Sods

Hoveland (1960) stated that there are two advantages to growing winter annual legumes in association with bermudagrass. First, the grazing season is extended by several months, because good quality forage is available when summer grasses are still dormant in the spring. Second, the legume is associated with N-fixing bacteria on their roots which make N available to the grass, thus stimulating bermudagrass growth in early summer. Bigflower vetch (Vicia grandiflora Scop.) grows rapidly in the spring and can eventually contribute up to 48 to 70% of the total herbage weight (Templeton and Taylor, 1975). For this reason, it can be a valuable aid in reducing the weeds that so often establish themselves well before the bermudagrass breaks dormancy.

Effect on Total Forage Production

When crimson clover (Trifolium incarnatum) was overseeded on Coastal bermudagrass, total forage production was increased approximately as much as when 67 kg of N/ha had been used without the legume (Holt et al., 1961). After the legume became dormant in late spring, the stand was fertilized with 135 to 168 kg of N/ha. Air-day forage yield per year was between 11,000 and 13,000 kg/ha, while the same amount of N without the legume resulted in 8,900 to 10,000 kg/ha of air-dry hay. Templeton and Taylor (1975) reported that bigflower vetch, a self-regenerating winter annual legume, increased the annual dry matter production of Midland bermudagrass and tall fescue more than did 100 kg N/ha but less than did 200 kg. Coastal bermudagrass following arrowleaf

(Trifolium vesiculosum Savi.) or crimson clover growth yielded 18% more dry matter than grass receiving 224 kg N/ha without clover (Knight, 1970). There was a certain amount of competition between the grass and arrowleaf clover that caused a reduction in Coastal production in the first harvest. However, total forage production was 47% higher from the sequence of clover-bermudagrass than from the grass alone fertilized with 224 kg N/ha. Average seedling counts for crimson and arrowleaf clovers were 272 and 528 seedlings per m^2 for annually seeded stands and self-reseeding stands, respectively. A disadvantage of seeding these winter annual legumes is that in years when spring moisture is limited, the legume may not leave adequate moisture for good bermudagrass growth.

Since a bermudagrass-legume mixture produces more forage early in the grazing season, Holt (1968) advocated the practice of using a combination of a winter legume followed by N applications of 168 kg/ha beginning about the time the winter annual legume matures (June 1). The results were an increase in air-dry forage yield of about 3,500 kg over N alone. Knight (1967) applied 224 kg N/ha on Coastal-crimson clover combinations and increased total dry matter yield by 25% when compared to Coastal with 224 kg N/ha and by 63% when compared to Coastal not fertilized with N. However, Utley et al. (1977) observed that crimson clover production in Coastal was effectively reduced by N fertilization levels of over 112 kg/ha.

Another concern, when attempting to keep legumes in grass sods, is the level of available P and exchangeable K in the soil. Hopkinson (1970) made broadcast applications of 200 kg/ha of P and 250 kg/ha of K on bermudagrass soon after the legume was established. In spite of this, the legume stand became patchy, and it was concluded that a high residual soil nitrogen enabled the grass to respond more to the fertilizer than the legume. Dry matter yield was increased by 6,000 kg/ha after the P and K applications.

Effect on Animal Performance

Blaser et al. (1956) demonstrated that steers grazing orchardgrass (Dactylis glomerata L.) or tall fescue fertilized with 240 kg N/ha had lower daily live-weight gains (0.49 and 0.40 kg/day, respectively) than steers grazing these same grasses grown with ladino clover (Trifolium repens L.) and not fertilized with N. Live-weight gains per animal were higher (0.54 and 0.46 kg/day, respectively) when grazing orchardgrass-ladino clover and orchardgrass fertilized with N than for the comparable two treatments of tall fescue. Tall fescue (242 kg N/ha) pastures supported the highest carrying capacity per season (411 steer-days) while orchardgrass-legume pastures had the lowest (204 steer-days). The N fertilized pastures produced slightly higher live-weight gains per acre than the same pastures with ladino clover and no N. When winter annual clovers were established in Coastal bermudagrass pastures, they increased the length of the grazing season by 84 to 120 days, improved the quality of available forage, and fixed 84 to 112 kg N/ha in the soil (Utley et al., 1977). Steers grazing crimson and arrowleaf clovers achieved a mean average daily gain of 0.9 kg/day for the period that the clovers grew. Animal grazing days per ha were 553 and 709 for crimson and arrowleaf clovers, respectively, with live-weight gains of approximately 561 kg/ha. Midland bermudagrass pastures overseeded with hairy vetch

(*Vicia villosa* Roth), crimson clover and ladino clover produced beef gains of 305 kg/ha compared to 203 kg/ha for Midland pastures fertilized with 112 kg/ha of N (Harlen et al., 1954). These winter annual legumes tend to give the highest yields in areas south of Tennessee, while white clover stands are often difficult to obtain where sufficient late spring and summer moisture is not available.

There is a distinct advantage in having legumes in pastures, even if there is only a slight increase in average daily gain. Blaser et al. (1956) observed that an increase as small as 0.14 kg in daily gain can make a difference of 28 kg live-weight gain per animal in a 200-day grazing season.

When ladino clover stands in orchardgrass and tall fescue pastures began to deteriorate (Blaser et al., 1956), they were reseeded, without disturbing the sod, at a cost that was small compared with the annual cost of applying nitrogen. Conversely, any annual legume could be kept from dominating bermudagrass by varying rates of N fertilizer (Malm et al., 1970).

The Introduction of Annual and Perennial Grasses in Bermudagrass Sod

Totusek et al. (1974) found that, although Midland bermudagrass is capable of producing substantial forage yields, it is sufficiently high in quality to promote a high rate of gain with stockers for only 60 to 90 days in the total year. Therefore, the introduction of improved forage species into existing pastures to supplement them during times of low production or dormancy has been the subject of much research.

Effect on Total Forage Production

The addition of cool season annual forage, such as rye, to the Midland sod slightly increased total forage production and extended the grazing season in both spring and fall, thus providing more uniform grazing (Decker et al., 1969). However, Robison and Jensen (1967) observed that the competition between bermudagrass and rye, when planted in combination, caused a reduction in the individual yields of both species to the point that total yearly yields were not appreciably increased; the real advantage was that there was a more desirable yearly distribution of growth. Hallock et al. (1966) also referred to the same yield depression when rye was overseeded into Midland sod. Nevertheless, the yield depression was less as N fertilization was increased and was negligible at the 898 kg/ha N level.

Due to the high cost of planting cool season annual grasses in warm season perennial sods, an experiment was conducted by Decker et al. (1974) to compare total forage yields and seasonal distribution of Midland in combination with cool season annuals, to Midland in combination with cool season perennial grasses (orchardgrass and tall fescue). Results indicated that although the perennials significantly increased total forage yields, production was still greater when the annuals were seeded. This occurred because Maryland summers are not sufficiently hot for a long enough time to cause dormancy of cool season perennials. Therefore, competition between the bermudagrass and perennial grasses prevents either species reaching full yield potential. This should not be the case in Tennessee. In Georgia, when tall fescue was seeded into dormant Coastal bermudagrass, the fescue persisted and contributed to the total yield at N levels up to 420 kg N/ha per year at the clipping height of 5 cm (Wilkinson et al., 1968). Tall fescue also persisted at N levels up to 560 kg N/ha per year at a 10 cm clipping height. N fertilization resulted in a decreased proportion of fescue in the stand, but the higher clipping increased the fescue percentage of the harvested forage. Large applications of N resulted in the highest yields but there was very little fescue in the harvested forage. Fribourg and Overton (1973) found that the presence of tall fescue reduced the production of Midland forage to 70% of that when grown alone. Total yield for the combination was 1.8 ton/ha of dry matter greater than for Midland alone; had these stands been grazed, they would have provided pasture from mid-February through mid-November.

Effect on Animal Performance

Four N applications were made on bermudagrass tall fescue pasture combinations to maintain a desirable balance of the two species (Spooner and Ray, 1974). This practice was found to increase the grazing season by 247 animal grazing days/ha and increased total gains anywhere from 67 to 101 kg/ha, compared to fertilizing in June and August for the benefit of bermudagrass alone. By increasing nitrogen fertilization from 135 to 539 kg N/ha on Midland pastures overseeded with ryegrass, yearly gains per steer increased from 105 to 158 kg, respectively. Grazing days increased by 28 days and steer days per ha increased from 827 to 1475 (McMurphy et al., 1975). Tall fescue and orchardgrass, each containing white clover or fertilized with 168 kg N/ha/year, were compared to Coastal bermudagrass sod-seeded with vetch or rye (Harris et al., 1972). Annual beef gain per ha averaged 889, 776 and 1265 kg, respectively. Total gain per animal was 83, 89 and 95 kg, respectively. Average daily gain of the steers did not improve when white clover was included in the orchardgrass sod, but the legume did increase average daily gain for tall fescue pastures (0.60 versus 0.66 kg/day). Midland-ladino clover pastures were overseeded with rye and produced more than 1010 kg gain/ha (Elder and Murphy, 1961). The carrying capacity for 8 months of grazing was 7.4 and 9.9 steers/ha. Burns et al. (1973) reported that during the dry summer months (May 31 to September 15) calves on tall fescue-ladino clover-Coastal bermudagrass pastures and tall fescue-Coastal bermudagrass pastures gained less than those on tall fescue-ladino clover pastures (73.1, 68.3 and 79.9 kg/season, respectively). The gains obtained from Coastal enabled the tall fescue-clover-bermudagrass treatment to compare favorably with tall fescue-clover treatment in total gains/season (118 kg and 122 kg, respectively). The bermudagrass provided grazing for 108 of the 161-day season. Spooner and Ray (1974) determined that approximately 17 fescue plants per square meter, would probably be the optimum density to produce maximum steer gains.

CHAPTER III

EXPERIMENTAL PROCEDURE

Experimental Pastures

A grazing experiment was conducted during the years 1975, 1976 and 1977. The experimental pastures used in this study were located at Ames Plantation near Grand Junction, Tennessee, on a fine-silty, mixed, thermic Typic Hapludalf (Memphis silt loam). There were six 1.2-ha Midland bermudagrass pastures and two orchardgrass-ladino clover pastures that had been established in 1969 and had been used in a previous experiment. Of the six bermudagrass pastures, two were overseeded each year with 1.4 kg/ha of ladino clover and 5.2 kg/ha Kobe lespedeza (Mid + legume) in midwinter (January 15 to February 28). Two other bermudagrass pastures had tall fescue planted within the sod in rows 25 cm apart (Mid + fescue). The last two bermudagrass pastures consisted entirely of Midland fertilized with 228 kg of nitrogen per hectare per year (Mid + N). The orchardgrass pastures were renovated as needed to reestablish the clover stands. In addition, two 1.2-ha pastures were seeded to tall fescue (fescue) in 1974. The experimental treatments and fertilization rates are described in detail in Table 1. Data were collected from these plots in 1975, 1976 and 1977, and the experimental design consisted of a randomized complete block with two replications.

TABLE 1. EXPERIMENTAL SETUP

Treatment	Fertilization applications (kg/ha)						Number of tester steers in each replication
	N		P		K		
	kg/ha	Average date	kg/ha	Average date	kg/ha	Average date	
Midland + legumes	—	—	25	3-20	95	3-20	3
Midland	80	3-20	25	3-20	95	3-20	5
	74	5-20					
	74	7-1					
Midland + fescue rows	80	3-20	25	3-20	95	3-20	3
	74	5-20					
	74	7-1					
	68	9-1	15	9-1	28	9-1	
Fescue	—	—	30	3-20	56	3-20	3
Orchardgrass + ladino clover	—	—	30	3-20	56	3-20	3

Sample Collection

The cage and strip method was employed to measure forage growth and consumption. On the day that the grazing season started each year, six strip samples per pasture were harvested at random, and six randomly distributed cages were placed on each experimental pasture. Subsequent harvests included both strip and cage forage samples. Harvest intervals were then determined depending on how pasture growth had progressed, thus shorter intervals prevailed in the spring and longer intervals occurred in the summer. All samples were obtained using a rotary mower with a collecting basket. The bermudagrass samples were harvested at a stubble height of 4-5 cm above the ground, while fescue and OG-clover samples were clipped at a stubble height of 7-8 cm. A swath of 50 cm was cut all around the former caged area which included 25 cm outside and 25 cm inside the area. The remaining 71 cm plus 71 cm area was then harvested as the sample. The mower strips were 50 cm wide and 6.1 m long. Individual samples were then placed in cotton bags, identified, oven dried at 65° C for 72 hours and weighed to the nearest gram. After each harvest, the cages and strips were randomly assigned to new locations using the fence posts as coordinates.

Grazing Management

The grazing season was initiated for the Midland bermudagrass pastures when Midland began to break dormancy (approximately April 1). At this time, the experimental animals were placed on the respective plots, and they remained there throughout the grazing season. The termination of grazing occurred from middle to late August when the pastures were grazed lower than 3 cm.

Experimental Animals

The yearling beef steers used in this study were purchased at a Tennessee feeder calf sale each year in the fall preceding the spring when grazing started. The weight of these animals ranged from 205-225 kg, and they graded either Good or Choice. From the time of their purchase until their subsequent use in the spring, these steer calves were wintered uniformly on hay to gain approximately 0.3 kg per head per day.

Initial and final weights for the grazing period were calculated by averaging the body weights taken on two consecutive days. Individual animal weights were recorded at approximately 21-day intervals during the grazing season. The stocking rate on the various pasture treatments was different (Table 1). Data from steers that remained on the experimental pastures throughout the grazing season (tester animals) were used to calculate growth parameters. Additional steers (put-and-take animals) were placed on these pastures at times of rapid forage growth to harvest excess forage and to keep the various plant species in a vegetative state. Data from these put-and-take animals were only considered when calculating number of grazing days per pasture.

After the animals were placed on the pastures, they received no supplemental feed. They were permitted access to salt, trace minerals, water and artificial shade at all times. To prevent accumulation of water under the shades the area was filled with soil or sand. Animals were wormed with phenothiazine when they were pruchased in the fall and again in early March.

Digestibility and Crude Protein Analyses

After being dryed and weighed, the cage and strip forage samples were allowed to air equilibrate (moisture content in balance with air). They were composited within pasture plots, and then ground in a Wiley mill to pass through a 20-mesh screen. The samples were stored in glass jars for subsequent crude protein and *in vitro* dry matter digestibility determinations.

In Vitro Digestibility of Forage

The rumen-fistulated steer from which the rumen liquor was obtained, was maintained on an alfalfa (*Medicago sativa* L.) hay diet two weeks prior to the first collection of rumen fluid and throughout the experiment. The Tilley and Terry (1963) artificial rumen technique was employed to determine *in vitro* dry matter digestibility (IVDDM). A succession of three separate analyses was made using rumen fluid obtained at the beginning of each analysis. All cage and strip samples (not replicated) were included in each of the three analyses.

Nitrogen Content of Forage

The samples were analyzed for total N, using an Autoanalyzer with a procedural modification of the method advocated by Thomas et al. (1967). Percent nitrogen was converted to crude protein (CP) by multiplying by 6.25.

Forage consumption and composition of consumed forage total dry matter (%DM) content was determined by taking a 1 to 2-g aliquot of each air equilibrated cage and strip sample and drying it at 100° C overnight. Total dry matter consumption was calculated by the following equation:

Total DM consumption (I,J,K) = (yield from cage {I,J,K} × %DM) - (yield from strip {I,J,K} × %DM)

where:

I = treatment

J = replication

K = period

The intake per animal of IVDDM, TDN and CP was calculated by the following steps:

1. IVDDM consumed per period, kg = (DM yield from cage, kg × %IVDDM) - (DM yield from strip, kg × %IVDDM)

2. %IVDDM in consumed forage = $\frac{\text{value from step 1}}{\text{total DM consumed per period, kg}}$ × 100.

3. IVDDM consumed per animal per day, kg = $\frac{\text{value from step 1}}{\text{animal days}}$

   a. animal days = number of elapsed days per period × number of animals grazing during the period

   b. number of animals = tester animals + put-and-take animals

4. IVDDM consumed per unit of metabolic weight, g per day =

   $\frac{\text{value from step 3}}{\text{metabolic weight, } W^{.75}_{kg}}$

5. IVDDM percentage of each cage and strip cut was converted to estimated TDN (ETDN) percentage by the equation:

   ETDN, % = 5.81 + 0.869 (IVDDM, %)

   (Heaney and Pigden, 1963).

6. Steps 1 through 4 were repeated to calculate ETDN consumption and composition of consumed forage. In addition, ETDN intake above maintenance was determined by the following calculation: ETDN intake above maintenance, kg/day = ETDN intake per animal per day, kg - maintenance requirement/day, kg

$$\text{TDN maintenance requirement, kg/day} = \frac{0.036\ W^{.75}_{lb}}{2{,}205}$$

(Garrett et al., 1959)

7. Steps 1 through 4 were repeated to calculate CP consumption and composition of consumed forage. In addition, CP intake above maintenance was determined by the following equation: CP intake above maintenance = (CP intake per animal per day, kg) - (maintenance requirement per day, kg)

$$\text{maintenance requirement, kg/day} = \frac{5.86\ W^{.75}_{kg}}{1{,}000}$$

(Preston, 1966)

Statistical Analysis

The original data were reduced to polynomial equations describing the effect of elapsed days of grazing on ETDN and CP content of available and consumed forage. Prediction equations were also derived from DM, ETDN, and CP consumption value changes over elapsed days of grazing.

The b values of these regression equations were obtained from a Statistical Analysis System (SAS, 1976) Program using the General Linear Models Procedure. The variation due to year and to replication was eliminated.

The relationship between the dependent and independent variable was determined to be either cubic, quadratic or linear by obtaining a significant or near significant F using the Type I (sequential) sums of squares.

CHAPTER IV

RESULTS AND DISCUSSION

Composition of Available Forage

Estimated Total Digestible Nutrient Content

Predicted ETDN values (Table 2) were calculated from the regression equations at monthly intervals, beginning in May and continued to either August 1 or September 1, depending on the harvest date of the last sample.

The change in ETDN content of the available forage containing Midland bermudagrass is presented in Figure 1 and Table 2. There were no differences in %ETDN of Midland + 200 kg N/ha (Mid + N) and Midland + legumes (Mid + legumes) throughout the season. Both were approximately 50% on May 1 and slowly decreased to approximately 42% by September 1. Carver (1975) reported %IVDDM values (which are similar to %ETDN values) of N fertilized Midland pasture forage. The results obtained in the present study differed from those reported by Carver (1975). The digestibility of available forage from his Midland pastures was lower in the spring but had not decreased as much during the grazing season and thus were higher by September 1. However, percent ETDN of Midland plus tall fescue (Mid + fescue), declined from 57% in May to approximately 47% by mid-June, leveled off until August, and decreased slightly to 43.3% on September 1. Midland bermudagrass matures later than fescue. Fribourg (1963) reported that a later maturing grass would tend to be

TABLE 2. PREDICTED MONTHLY CHANGES IN COMPOSITION OF AVAILABLE PASTURE FORAGE

		Pasture treatments				
Date	Elapsed days of grazing	Midland + 200 kg N/ha	Midland + legumes	Midland + tall fescue	Tall fescue	Orchardgrass + ladino clover
		Estimated total digestible nutrients, %				
May 1	35	49.2	48.8	57.0	68.7	53.4
June 1	66	47.5	47.1	48.5	61.4	50.1
July 1	96	45.8	45.4	46.6	48.5	49.2
Aug. 1	127	44.0	43.7	46.5	59.8	50.8
Sept. 1	158	42.3	42.0	43.3	—	—
R^2		0.58[a]	0.76[a]	0.71[a]	0.70[a]	0.40[a]
		Crude protein, %				
May 1	35	16.5	8.4	13.5	17.7	15.6
June 1	66	13.3	11.6	12.9	16.0	12.6
July 1	96	13.6	13.0	14.6	16.4	13.9
Aug. 1	127	14.2	12.6	15.9	19.0	15.2
Sept. 1	158	11.3	10.4	13.9	—	—
R^2		0.24[a]	0.85[a]	0.53[a]	0.71[a]	0.32[a]

[a]Fraction of the variation in original data in each response variable that was explained by elapsed days of grazing.

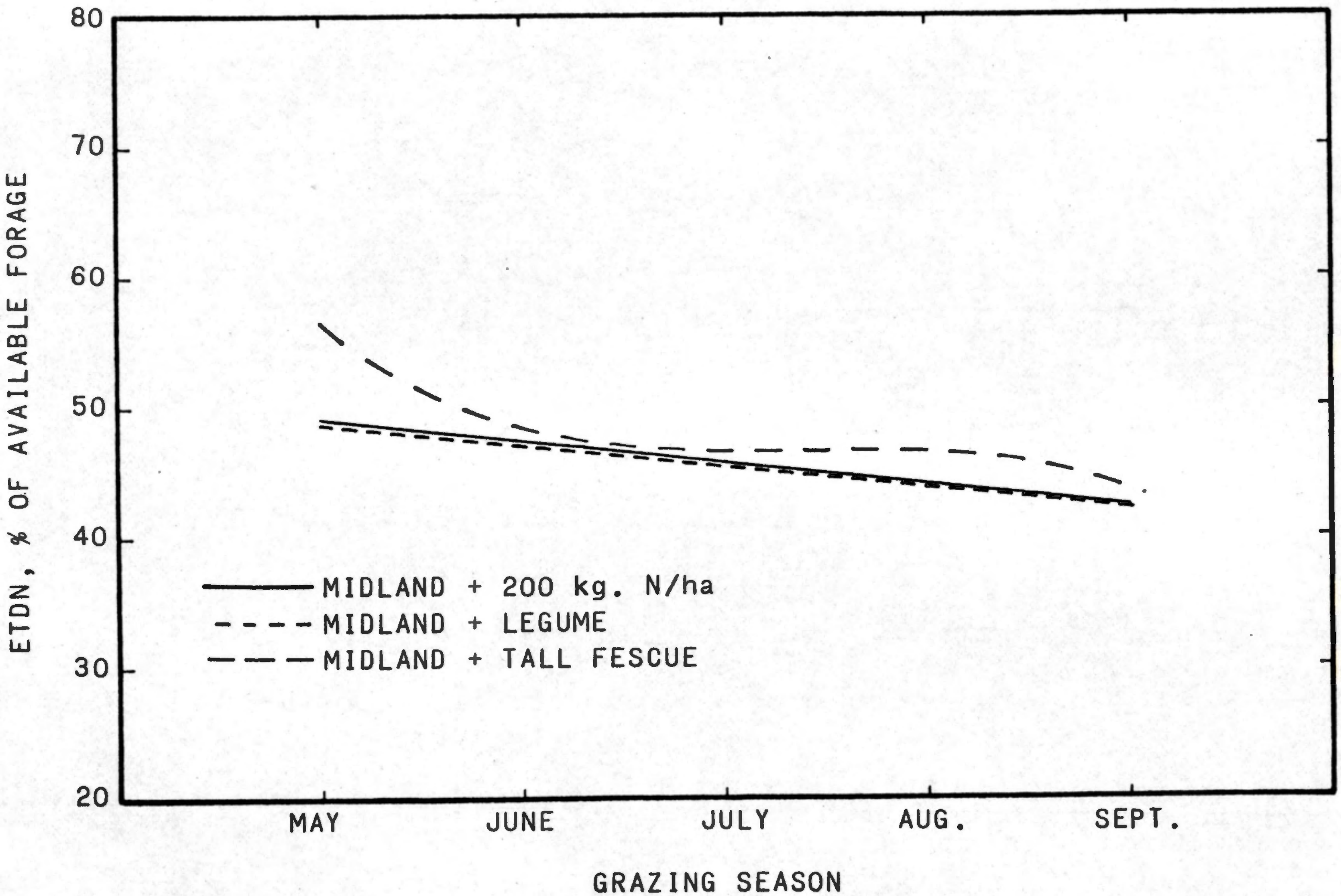

Figure 1. ETDN content of available forage from Midland bermudagrass fertilized with nitrogen or overseeded with either legumes or tall fescue.

less digestible and thus have a lower ETDN content on a specific date in the early spring than would an earlier maturing grass.

In Figure 2 the ETDN content of Mid + fescue was compared to that of tall fescue (fescue) alone. ETDN percentage of fescue was considerably higher than that of Mid + fescue from May through July, at which time the grazing of the fescue treatment was terminated. Predicted %ETDN of the available fescue forage was 68.7% on May 1. By July 1 %ETDN had decreased to 58.5% but soon began to gradually increase up to August. Apparently the portion of the less digestible Midland in the total forage tended to decrease the %ETDN of the total forage during the grazing season.

When the %ETDN prediction curve for available orchardgrass plus ladino clover (OG + clover) was compared to that of Mid + legumes (Figure 3) it was apparent that OG + clover was from 3 to 4% higher in ETDN content from May 1 until mid-June. From that time on, the %ETDN of OG + clover forage changed very little while that of Mid + legumes forage continued to decline for the remainder of the season. Carver (1975) reported similar trends when he compared Midland fertilized at high rates of N to orchardgrass and clover. The TDN requirement of a 300 kg steer fed to gain at least 0.5 kg/day is 57% of the ration (NRC, 1970). The only Midland-containing treatment to accomplish this was Mid + fescue and then for only the first day in May. Fescue remained above 57% over the total grazing season while OG + clover was never higher than 53.4% ETDN. The changes over time in fescue digestibility agreed with those reported by Barth et al. (1972) but differed from the digestibility results he reported for OG + clover. The lower ETDN percentage of OG +

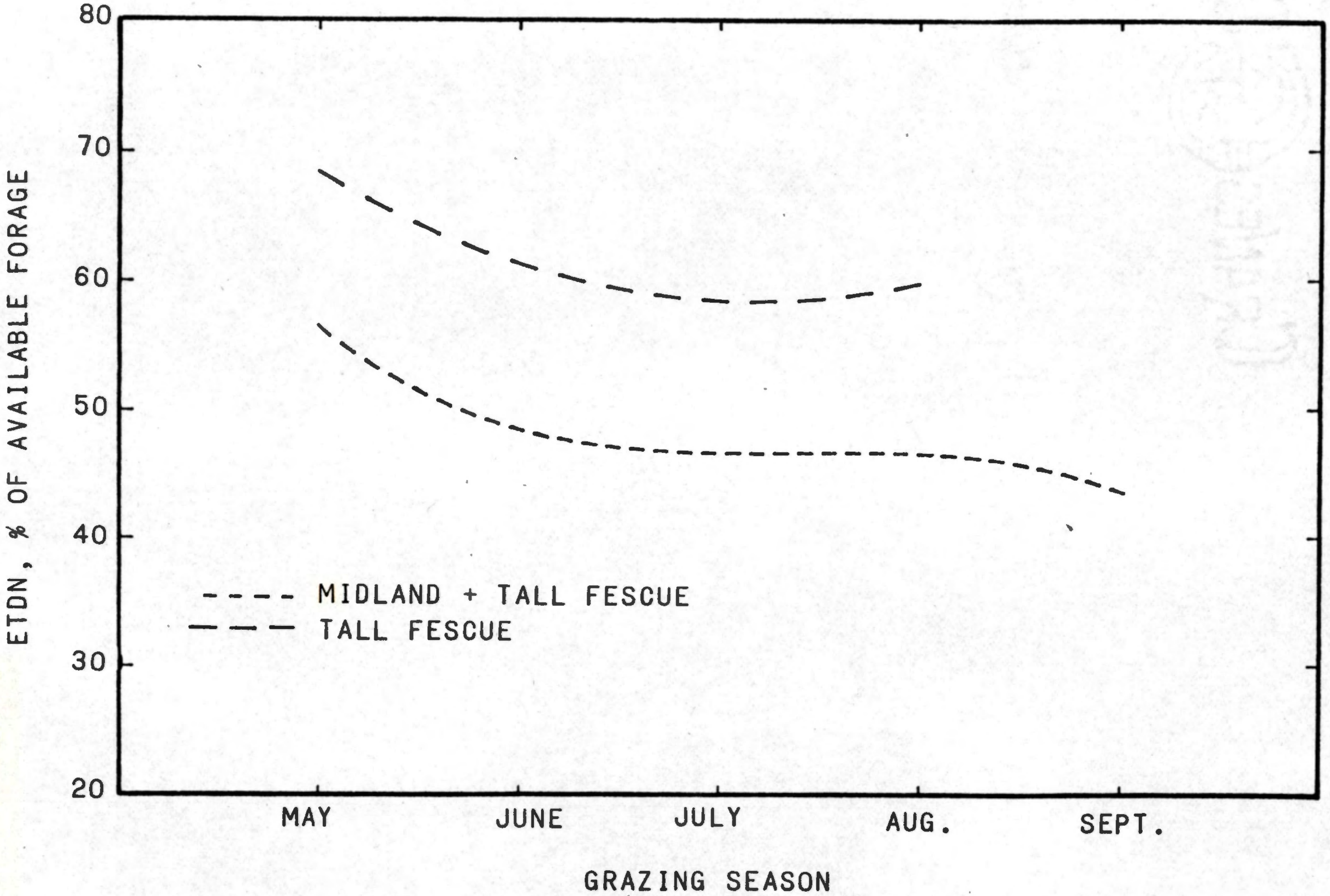

Figure 2. ETDN content of available forage from Midland bermudagrass overseeded with tall fescue and tall fescue alone.

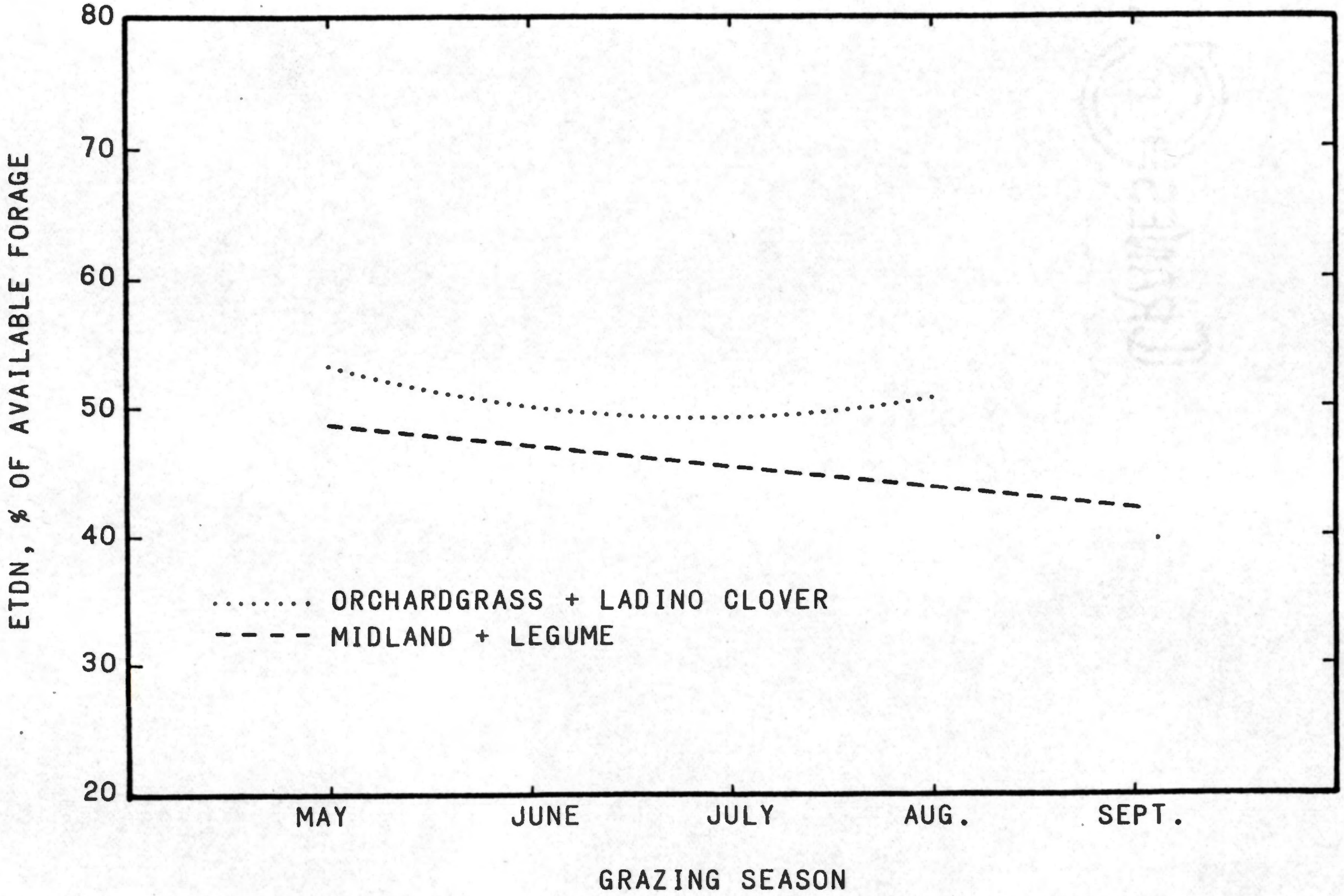

Figure 3. ETDN content of available forage from Midland bermudagrass overseeded with legumes and orchardgrass plus clover.

clover pasture forage compared to that of fescue forage was in contrast to results of most other workers and was not understood.

The prediction equations explained from 40 to 76% of the variability in the ETDN in the available forage (Table 2, page 24).

Crude Protein Content

The Midland + N pastures were 3% higher in CP content than Mid + fescue and 8% higher than Mid + legumes at the beginning of the grazing season (Figure 4 and Table 2). Carver (1975) and Horn and Taliaferro (1974) demonstrated that nitrogen fertilization resulted in an increase in CP content of Midland bermudagrass forage. However, from the second week of June, the %CP of Mid + fescue forage was higher than that of Mid + N forage and remained that way for the rest of the season. This might have been due to the use of some residual N by the bermudagrass that was unused earlier by the fescue. Carver (1975) also experienced a rapid decline in %CP in Midland forage at the beginning of the grazing season but not the increase from mid-June to the beginning of August. The regression line of %CP in available Mid + legumes demonstrates that this forage was lower in CP content than either of the other Midland-containing treatments for the entire grazing season. CP content for Mid + legumes started at 8.4% in May and increased through June to 13% by July 1. Contrary to what Carver (1975) reported, N fertilization was quite necessary in early spring. After mid-July the Mid + legumes forage displayed the decrease observed in the other Midland-containing forages, probably because of the apparent disappearance of white clover from the pasture.

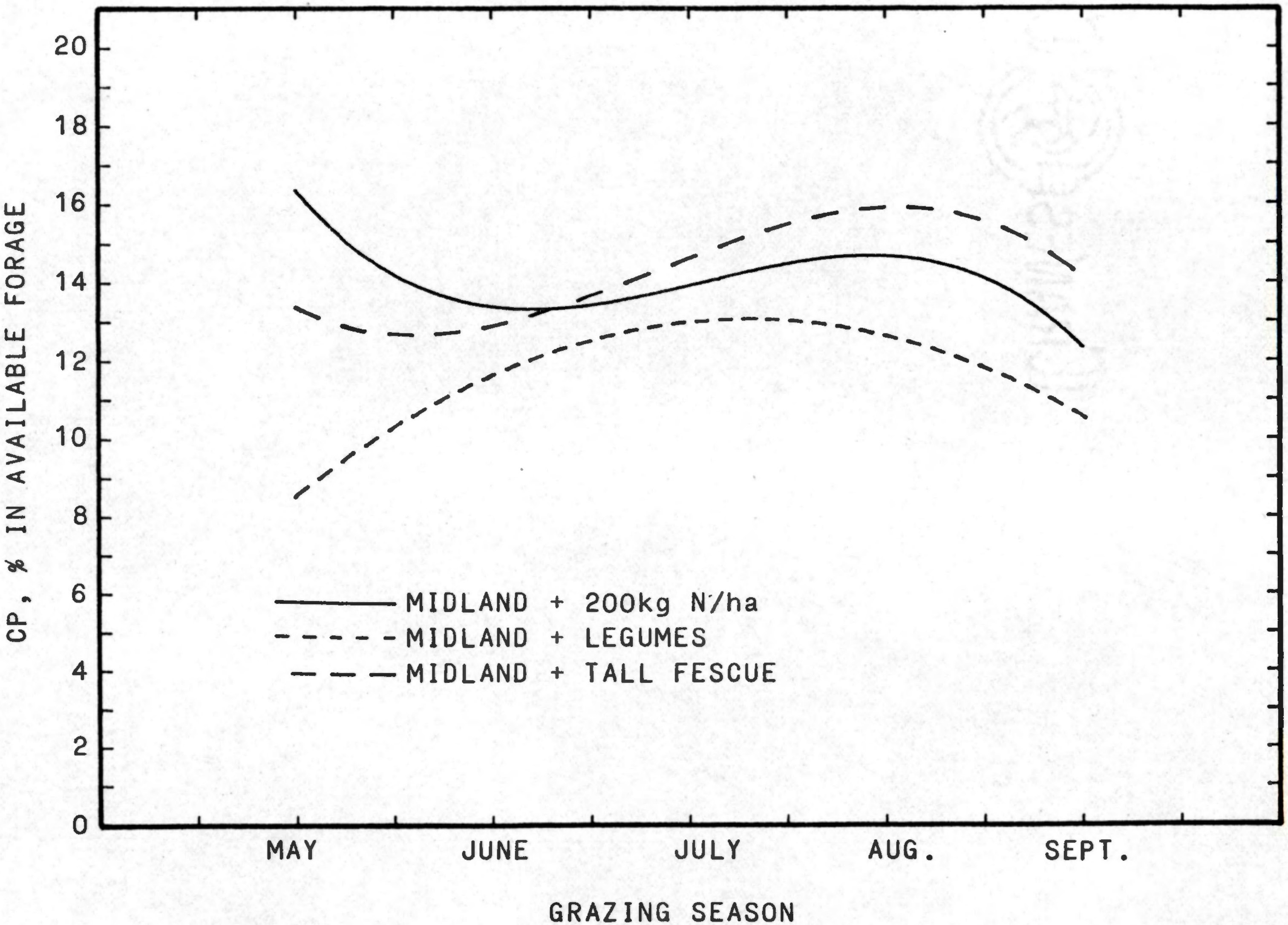

Figure 4. CP content of available forage from Midland bermudagrass fertilized with nitrogen or overseeded with either legumes or tall fescue.

The CP content of fescue forage was greater than that of Mid + fescue forage (Figure 5) throughout the grazing season. On May 1 %CP were 17.7 and 13.5%, respectively, for these two pastures. Fescue forage decreased to 16% CP in early June but steadily increased to 19% by August 1. These same trends were shown by Barth et al. (1972).

The decrease in CP content of available OG + clover forage was very rapid for the first 15 days (Figure 6). The decrease became less rapid by the end of May and by mid-June there was less difference (5%) in %CP between OG + clover and Mid + legumes than at any other time. Nevertheless, the CP content of OG + clover increased steadily to 15.2% on August 1, while Mid + legumes peaked at 13% in early July and decreased thereafter. The regression line for OG + clover (Figure 6) did not agree with the results of Barth et al. (1972) who reported an increase in %CP from May 1 to June 1 of over 3%, a leveling off for two months at approximately 17%, and a sharp decrease during August.

The CP requirement of a 300 kg steer, fed to gain at least 0.5 kg/day, is 10% of the ration (NRC, 1970). Forage CP levels above this requirement are not necessarily beneficial (Barth et al., 1972). The only treatment to fall below the CP requirement for available forage was Mid + legumes, which did so at the beginning of the season (8.4%). This was believed to be due to a lack of legume or a lack in the ability of the legume to supply N to the bermudagrass at that time. CP content in that treatment was quite sufficient for the rest of the season and was never deficient in any of the other treatments.

The small coefficients of determination (R^2) for Mid + N and OG + clover indicated that the time during the grazing season had little

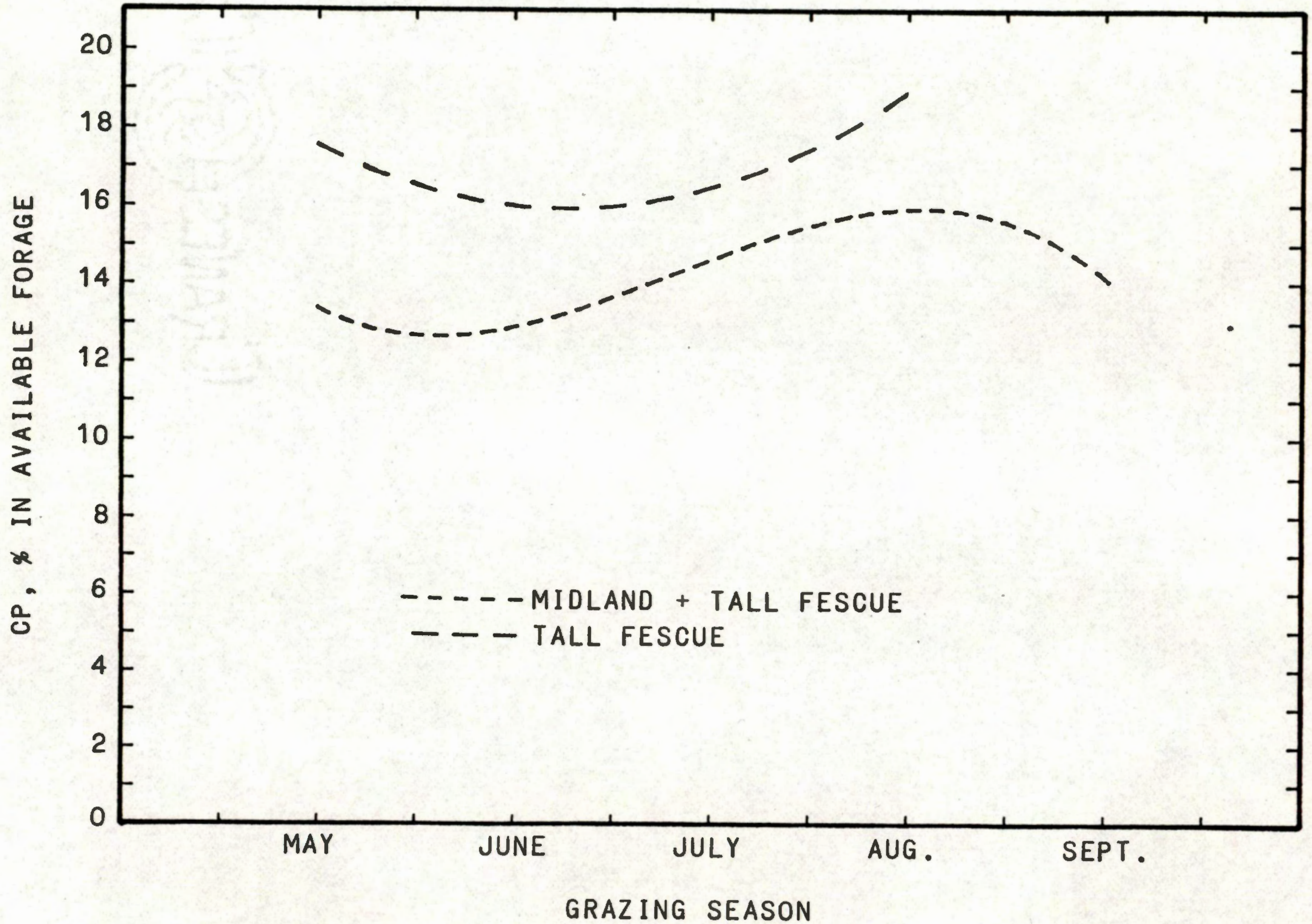

Figure 5. CP content of available forage from Midland bermudagrass overseeded with tall fescue and tall fescue alone.

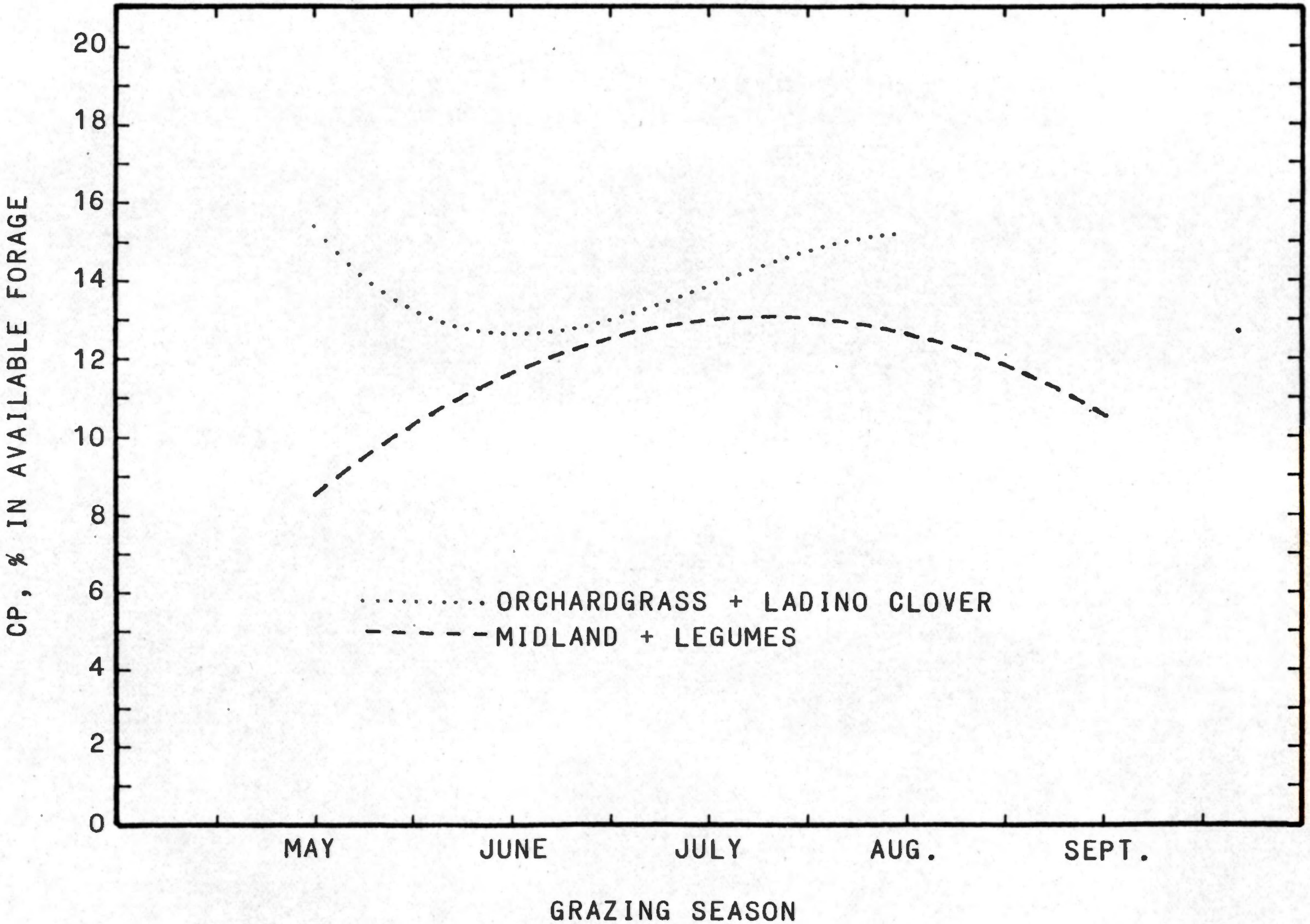

Figure 6. CP content of available forage from Midland bermudagrass overseeded with legumes and orchardgrass plus clover.

effect on the CP content of this forage (Table 2, page 24). However, the CP content of Mid + legumes, Mid + fescue and fescue was affected much more by elapsed days of grazing.

Composition of Consumed Forage

Estimated Total Digestible Nutrients

In Table 3 the predicted monthly ETDN values obtained from the regression lines fitted for each treatment are reported. A comparison of the pastures containing Midland is shown in Figure 7. Mid + fescue forage appeared to be initially higher in %ETDN of consumed forage than those of Mid + N and Mid + fescue (59.2, 57 and 53.8%, respectively). ETDN content of these three consumed forages decreased at various rates until mid-June when all steers were consuming forage with the same ETDN percentage (52%). From mid-June differences in %ETDN became quite pronounced. Mid + fescue forage started to increase rapidly in the quality of consumed forage during July. The high summer temperatures may have decreased enough to increase the amount of fescue in the pasture towards the end of the summer. The quality of the consumed Mid + legumes and Mid + N decreased during August and by September 1 were 48 and 42.7% ETDN, respectively. The legume in the Mid + legume treatment was most likely responsible for keeping the quality of consumed Midland forage higher than that of N-fertilized Midland.

Consumed Mid + fescue and fescue forage contained nearly the same amount of ETDN (59.2 and 60.6%, respectively) at the start of the season (Figure 8). This might have been due to both pastures being mainly fescue at that time of year. However, fescue essentially stayed the

TABLE 3. PREDICTED MONTHLY CHANGES IN COMPOSITION OF CONSUMED PASTURE FORAGE

		Pasture treatments				
Date	Elapsed days of grazing	Midland + 200 kg N/ha	Midland + legumes	Midland + tall fescue	Tall fescue	Orchardgrass + ladino clover
		Estimated total digestible nutrients, %				
May 1	35	57.0	53.8	59.2	60.6	60.5
June 1	66	53.4	52.3	53.0	60.9	57.2
July 1	96	50.0	50.9	52.0	60.9	55.0
Aug. 1	127	46.3	49.4	56.3	60.4	—
Sept. 1	158	42.7	48.0	—	—	—
R^2		0.50[a]	0.48[a]	0.17[a]	0.07[a]	0.28[a]
		Crude protein, %				
May 1	35	15.4	13.7	9.7	14.5	16.7
June 1	66	13.7	11.8	14.2	16.7	18.7
July 1	96	12.1	10.1	18.3	18.8	18.3
Aug. 1	127	10.5	8.2	—	21.0	15.3
Sept. 1	158	8.8	6.4	—	—	—
R^2		0.41[a]	0.78[a]	0.49[a]	0.26[a]	0.21[a]

[a]Fraction of the variation in the original data in each response variable that was explained by elapsed days of grazing.

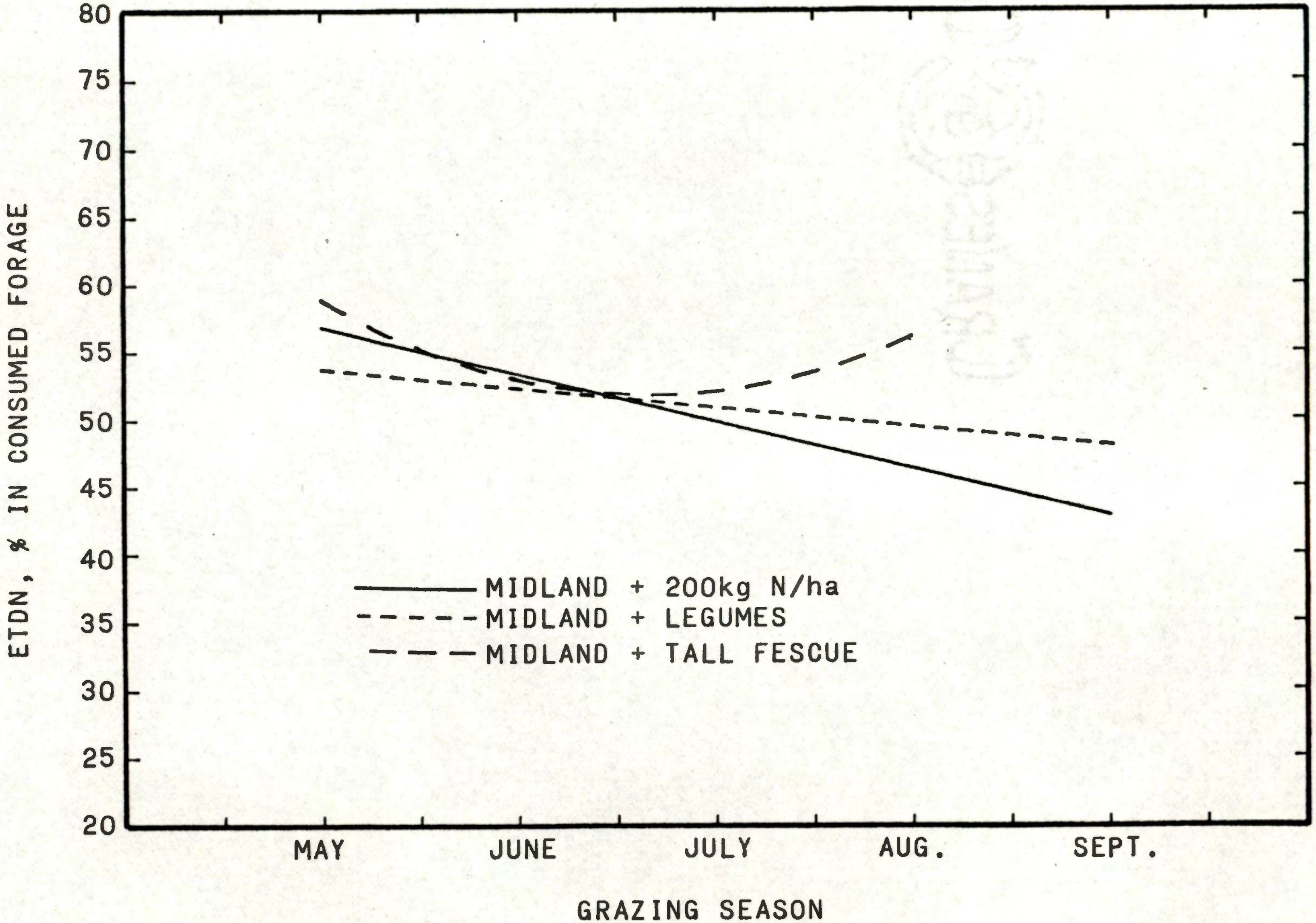

Figure 7. ETDN content of consumed forage from Midland bermudagrass fertilized with nitrogen or overseeded with either legumes or tall fescue.

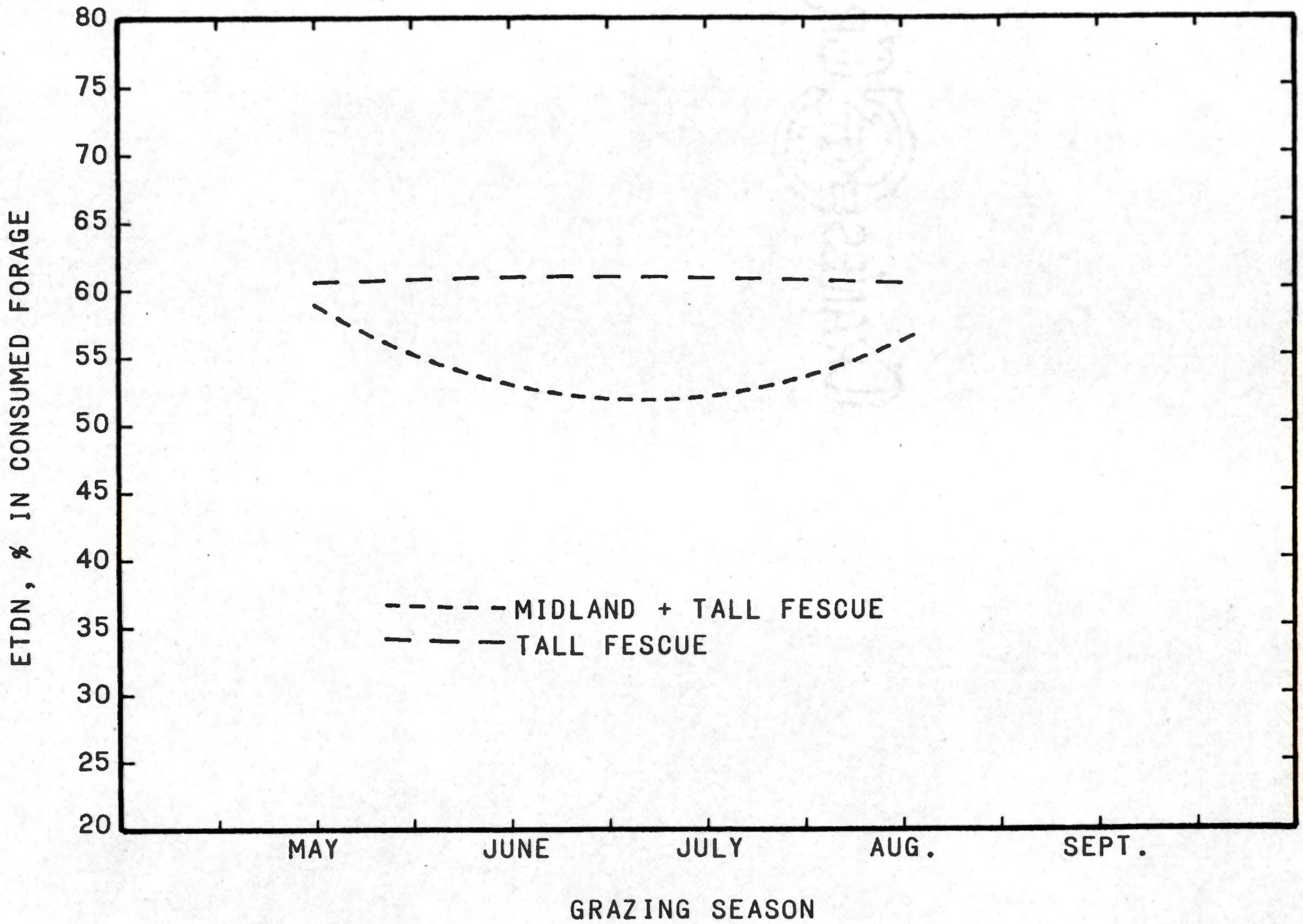

Figure 8. ETDN content of consumed forage from Midland bermudagrass overseeded with tall fescue and tall fescue alone.

same through the entire grazing season, while Mid + fescue, as stated earlier, declined in digestibility of consumed forage (52%) but increased between late June and August 1. The majority of the Mid + fescue pasture probably consisted of low digestible Midland in late June.

Over the entire season, OG + clover forage was shown to be higher in %ETDN in consumed forage than that of Mid + legumes (Figure 9). Consumed OG + clover was 6.7% higher in ETDN on May 1. Forage consumed from Mid + legumes and OG + clover pastures decreased in digestibility until mid-June when that of OG + clover had a rapid increase in quality early in July. Nevertheless, steers continued to consume Mid + legumes forage that declined in %CP.

The R^2 values indicated that the change in %ETDN of consumed Mid + N and Mid + legumes was attributable to elapsed days of grazing, while the time during the season affected the ETDN content of consumed Mid + fescue, fescue and OG + clover very little (Table 3).

The TDN requirement of a 300 kg steer gaining at least 0.5 kg/day is 57% (NRC, 1970) of the ration. In this case, Mid + legumes was never consumed at that level of TDN, while consumed Mid + N was only 57% the first day of the grazing season. Consumed Mid + fescue forage was above 57% ETDN for the first week in May. Animals never grazed fescue forage that was lower than 60% during the entire grazing period, and consumed OG + clover was deficient in ETDN content only in the latter part of June and early July.

Crude Protein Content

A comparison of Mid + N, Mid + legumes and Mid + fescue is illustrated in Figure 10. Consumed Mid + N and Mid + legumes forage

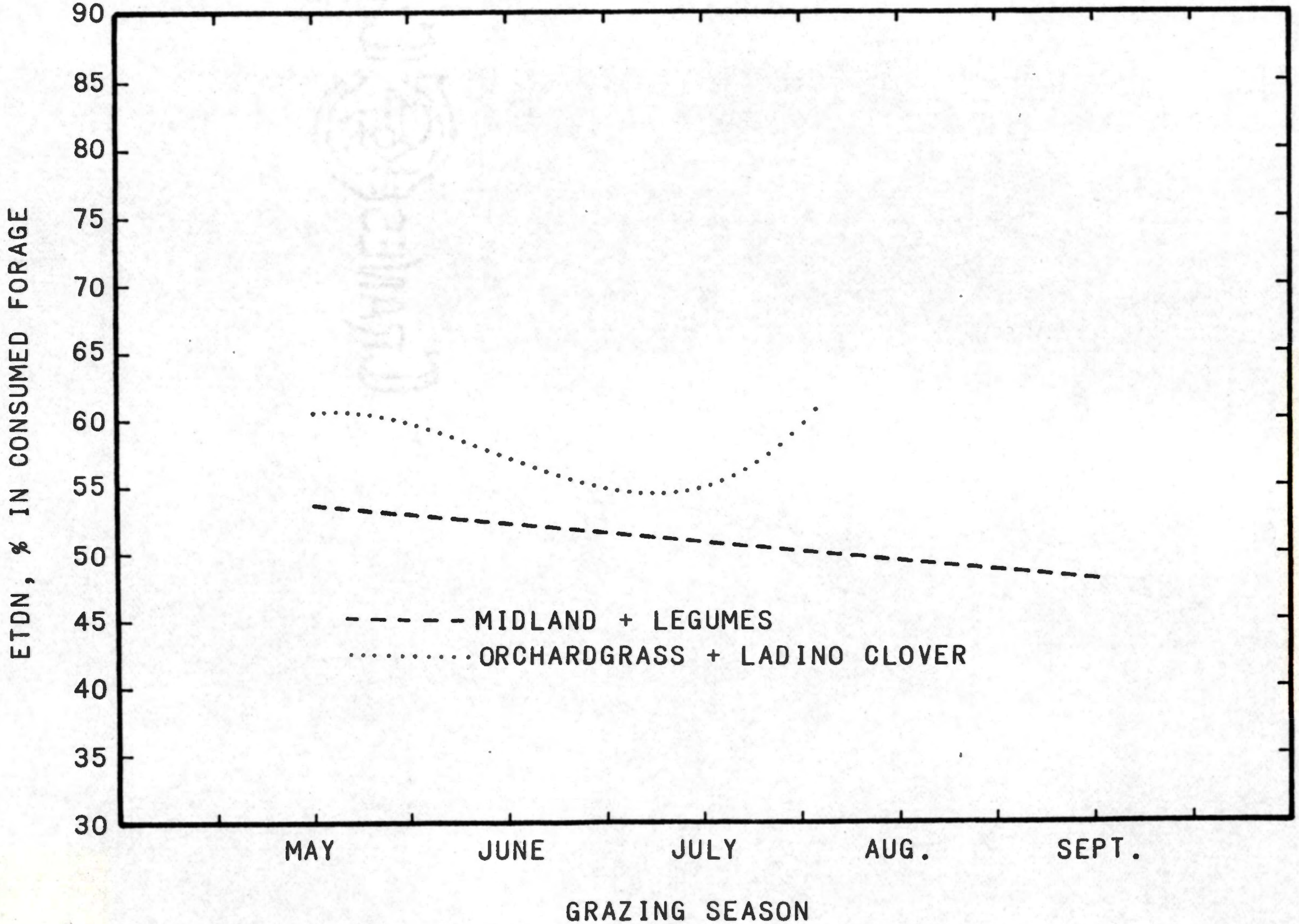

Figure 9. ETDN content of consumed forage from Midland bermudagrass overseeded with legumes and orchardgrass plus clover.

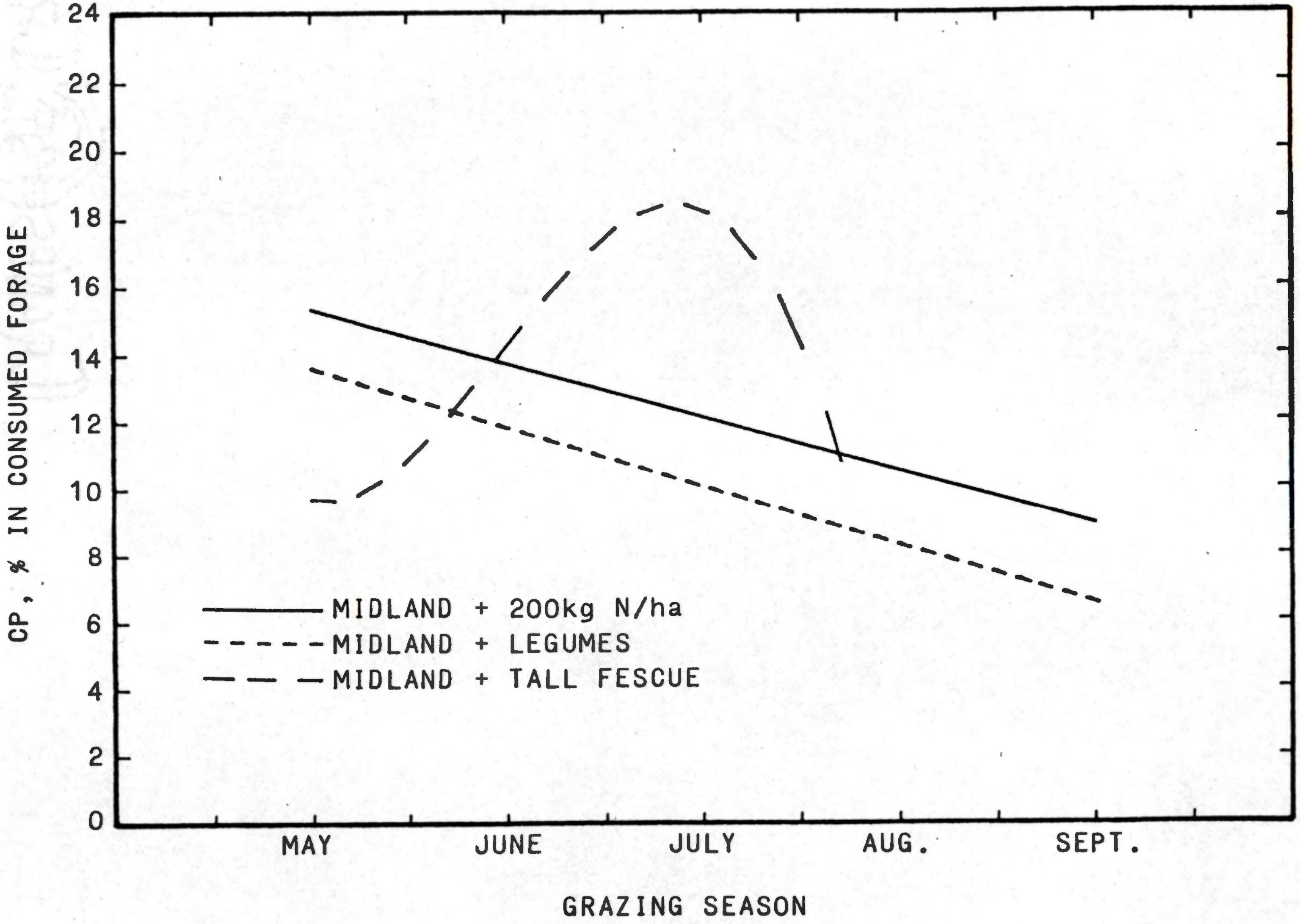

Figure 10. CP content of consumed forage from Midland bermudagrass fertilized with nitrogen or overseeded with either legumes or tall fescue.

began the season at 15.4 and 13.7% CP, respectively, and decreased thereafter at approximately the same rate (Table 3, page 35). Conversely, consumed Mid + fescue forage increased very rapidly from 9.7% in early May to 18.3% on July 1, followed by a drastic reduction during early July. Blaser (1964) found that, when grass is liberally fertilized with nitrogen, the decrease in soluble carbohydrates content is compensated for by an increase in protein, which may be utilized for energy. Thus, the TDN and/or digestible energy of grass forage is not appreciably altered by N fertilization. It seems likely that if the %CP in consumed forage declined then the soluble carbohydrates might increase enough to cause %ETDN to increase (Figure 8).

Although the difference in CP content of consumed Mid + fescue and fescue (Figure 11) was quite large on May 1 (9.7 and 14.5%, respectively), Mid + fescue increased at a much faster rate, so that there was little difference between the two forages by the third and fourth week in June. However, consumed fescue continued to increase and consumed Mid + fescue forage, as observed earlier, decreased very rapidly for the remainder of the grazing season.

In Figure 12, Mid + legumes and OG + clover were compared for %CP in the consumed forage. OG + clover was superior in this variable throughout the season, showing a gradual increase (2%) through May and a slight decrease (3.4%) from mid-June to August 1. Barth et al. (1972) described a similar increase in May of the %CP in available orchardgrass and clover forage followed by a decline in late summer.

Elapsed days of grazing had a substantial effect on the %CP in consumed Mid + legumes as evidenced by the coefficients of determination

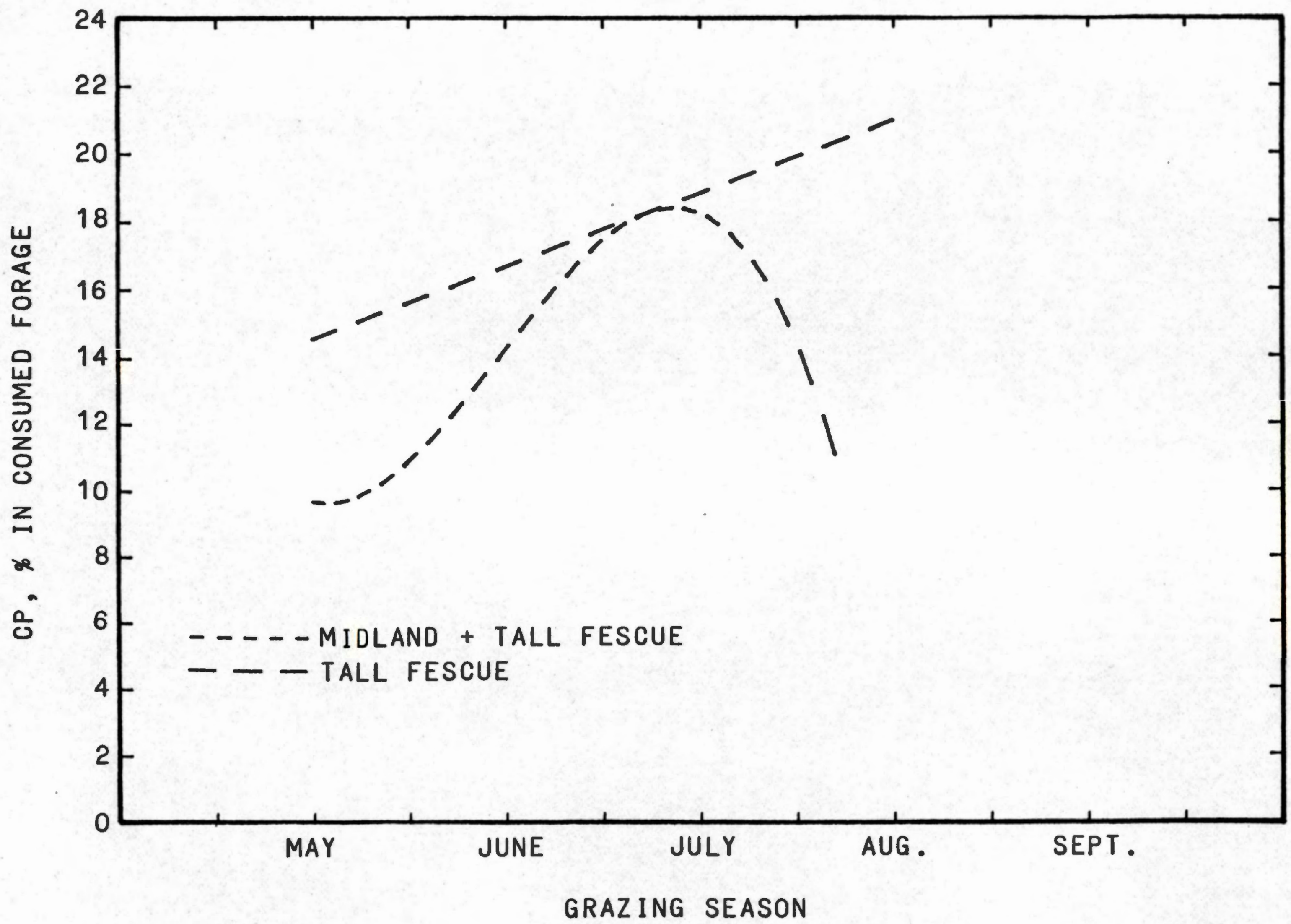

Figure 11. CP content of consumed forage from Midland bermudagrass overseeded with tall fescue and tall fescue alone.

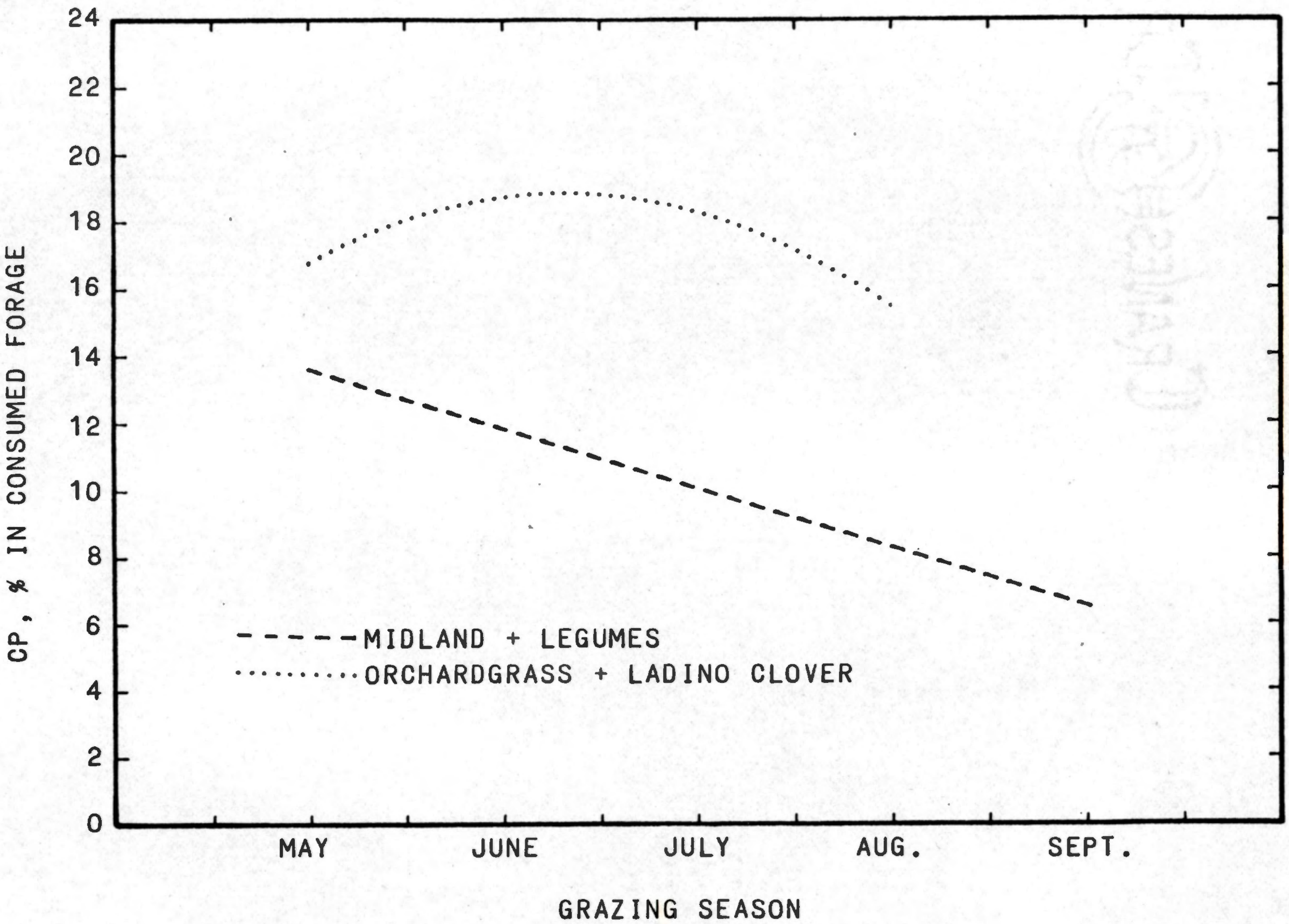

Figure 12. CP content of consumed forage from Midland bermudagrass overseeded with legumes and orchardgrass plus clover.

in Table 3, page 35. The %CP in the other treatments were not affected that greatly by the days of the growing season.

The %CP required for a 300 kg steer to gain 0.5 kg/day is at least 10% of the ration. Fescue and OG + clover were sufficiently high in CP for such ADG the whole season (Table 2, page 24). Mid + N and Mid + legumes were adequately high in CP through July and June, respectively, and Mid + fescue was deficient in %CP during the first few days of May and from the last week in July until the end of the season.

Amount of Intake

Dry Matter

DM consumption for animals grazing Mid + fescue and Mid + legumes decreased from May through August (Figure 13 and Table 4). Mid + legumes was consumed in larger (about 2 kg) amounts than Mid + fescue at the beginning of the grazing season, but this difference became smaller until late July when steers consuming Mid + fescue forage surpassed those grazing Mid + legumes in DM consumption for the remainder of the season. Hoveland (1960) found that in Alabama the presence of an overseeded legume would stimulate earlier growth from bermudagrass. Except for a brief period in late spring and the latter part of August, Mid + N was consumed at a lower level than either of the two treatments containing Midland.

On May 1, fescue alone resulted in a 2.5 kg higher DM consumption level than Mid + fescue (Figure 14). However, fescue consumption decreased very rapidly and by mid-June had fallen below Mid + fescue DM consumption for the rest of the grazing season. Since fescue is a cool

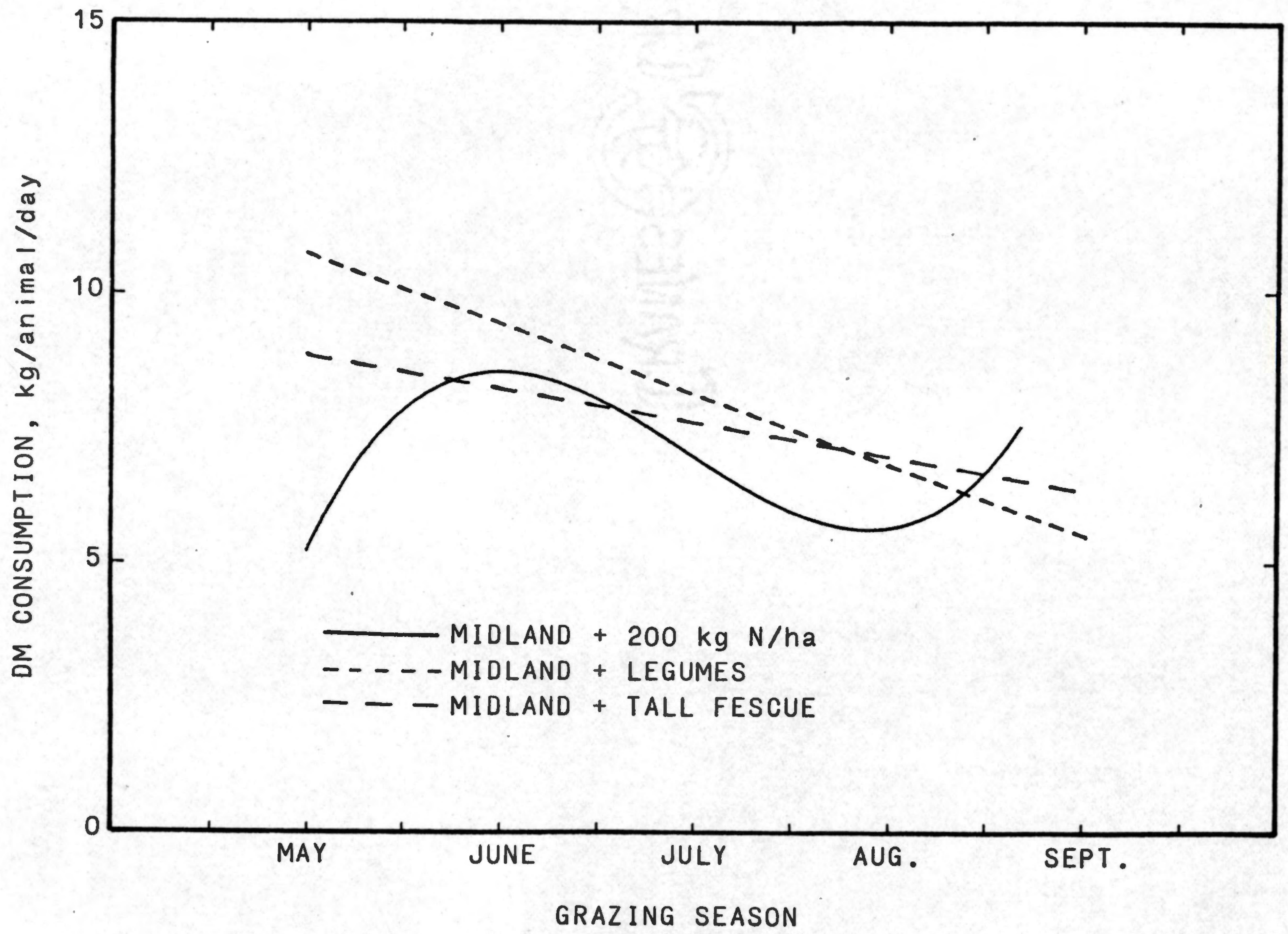

Figure 13. DM consumption from Midland bermudagrass fertilized with nitrogen or overseeded with either legumes or tall fescue.

TABLE 4. PREDICTED MONTHLY CHANGES IN NUTRIENT CONSUMPTION

Date	Elapsed days of grazing	Pasture treatments: Midland + 200 kg N/ha	Midland + legumes	Midland + tall fescue	Tall fescue	Orchardgrass + ladino clover
		Dry matter consumption, kg/day				
May 1	35	4.96	10.78	8.88	11.37	4.14
June 1	66	8.54	9.43	8.23	8.81	4.66
July 1	96	6.97	8.13	7.61	6.34	5.88
Aug. 1	127	5.67	6.79	6.96	3.78	—
Sept. 1	158	—	5.44	6.31	—	—
R^2		0.29[a]	0.25[a]	0.42[a]	0.59[a]	0.33[a]
		Estimated total digestible nutrient consumption, kg/day				
May 1	35	5.00	6.01	5.20	7.17	3.62
June 1	66	4.28	5.04	4.66	5.53	3.84
July 1	96	3.59	4.10	4.15	3.94	4.05
Aug. 1	127	2.88	3.13	3.62	2.29	1.86
Sept. 1	158	2.17	2.15	3.09	—	—
R^2		0.34[a]	0.23[a]	0.46[a]	0.57[a]	0.20[a]
		Crude protein consumption, kg/day				
May 1	35	—	1.51	1.12	1.57	0.66
June 1	66	1.25	1.11	1.18	1.33	0.93
July 1	96	0.72	0.72	1.11	1.09	1.08
Aug. 1	127	0.39	0.32	0.88	0.85	—
Sept. 1	158	—	—	0.51	—	—
R^2		0.63[a]	0.43[a]	0.42[a]	0.50[a]	0.32[a]

[a]Fraction of the variation in the original data in each response variable that was explained by elapsed days of grazing.

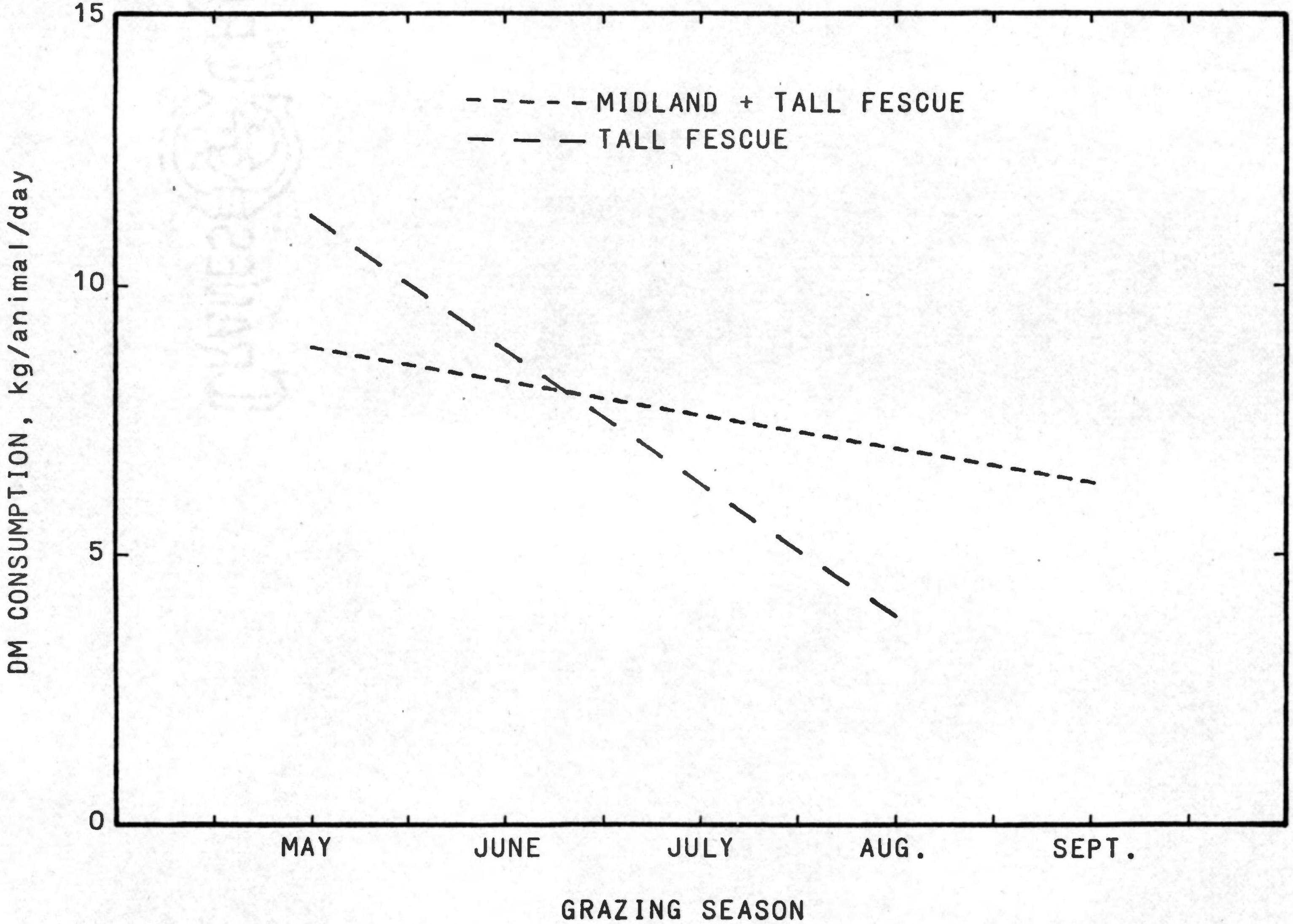

Figure 14. DM consumption from Midland bermudagrass overseeded with tall fescue and tall fescue alone.

season perennial, it tends to become dormant in the hot summer months, thus, less forage would be available for consumption at that time. However, the combination of a cool and a warm season perennial supplied a more even distribution of forage.

Although DM intake from OG + clover pastures increased from the second week in May until late June, consumption was never as high as that from Mid + legumes pastures (Figure 15). Assuming the legumes supplied the same amount of nitrogen to both orchardgrass and Midland, it seemed probable that the bermudagrass might respond more, and therefore would provide more available DM for consumption. In addition, cool season perennials, such as orchardgrass, become dormant in the hot summer months and thus yield very little DM.

The coefficients of determination (R^2) in Table 4 indicated that elapsed days of grazing affected DM consumption from fescue and Mid + fescue pastures more than the other pastures (R^2 = 0.59 and 0.42, respectively).

Estimated Total Digestible Nutrients

Animals grazing pastures containing Midland decreased their ETDN intake per day throughout the season (Figure 16). Mid + legumes was consumed at the highest rate of 6.01 kg ETDN per day on May 1 (Table 4). However, the level of ETDN consumption of Mid + legumes forage declined somewhat more rapidly than that of either Mid + N or Mid + fescue pasture forages. This may have been due to a decrease in proportion of legumes brought on by hot temperatures of the summer months. With the legumes being the more digestible portion of the Mid

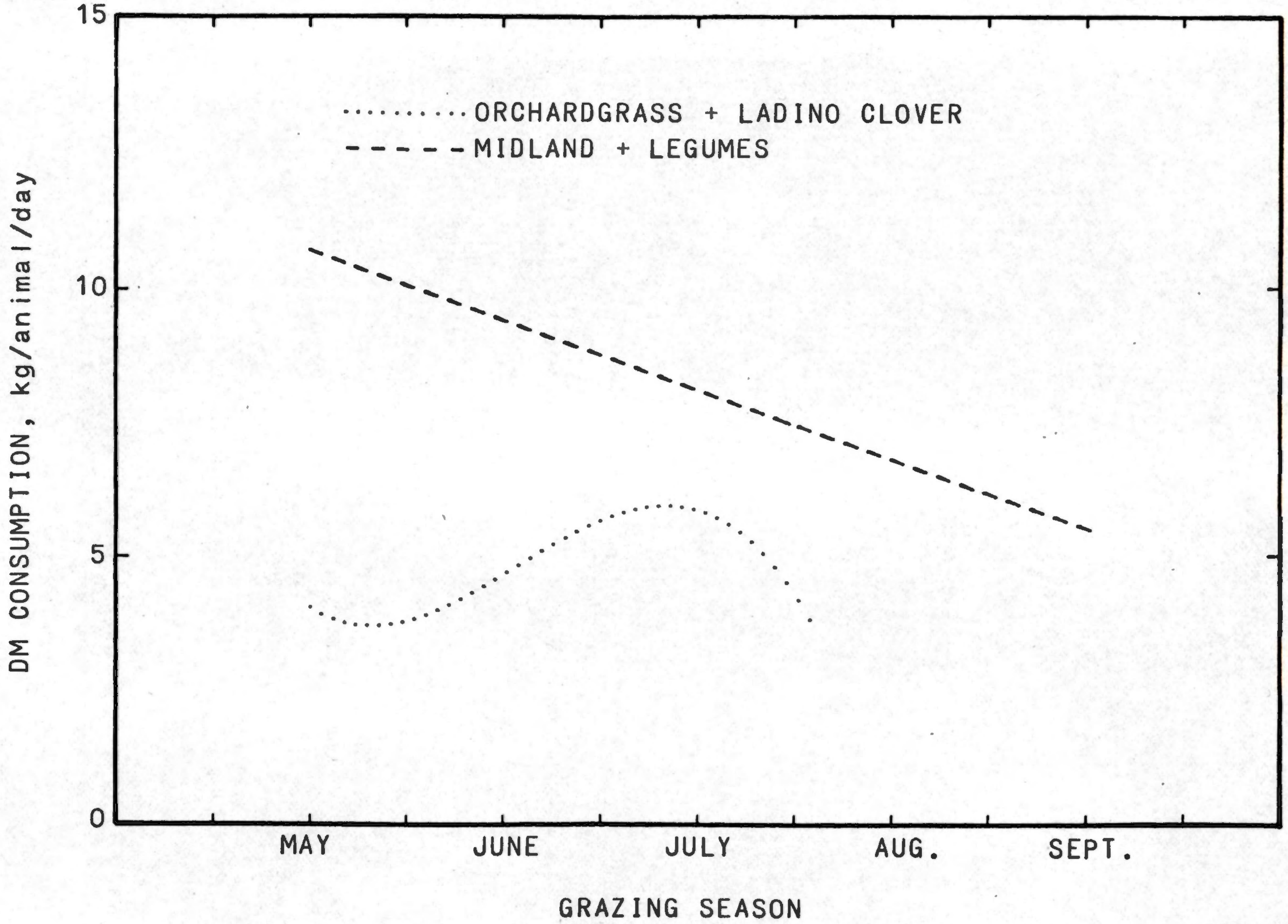

Figure 15. DM consumption from Midland bermudagrass overseeded with legumes and orchardgrass plus clover.

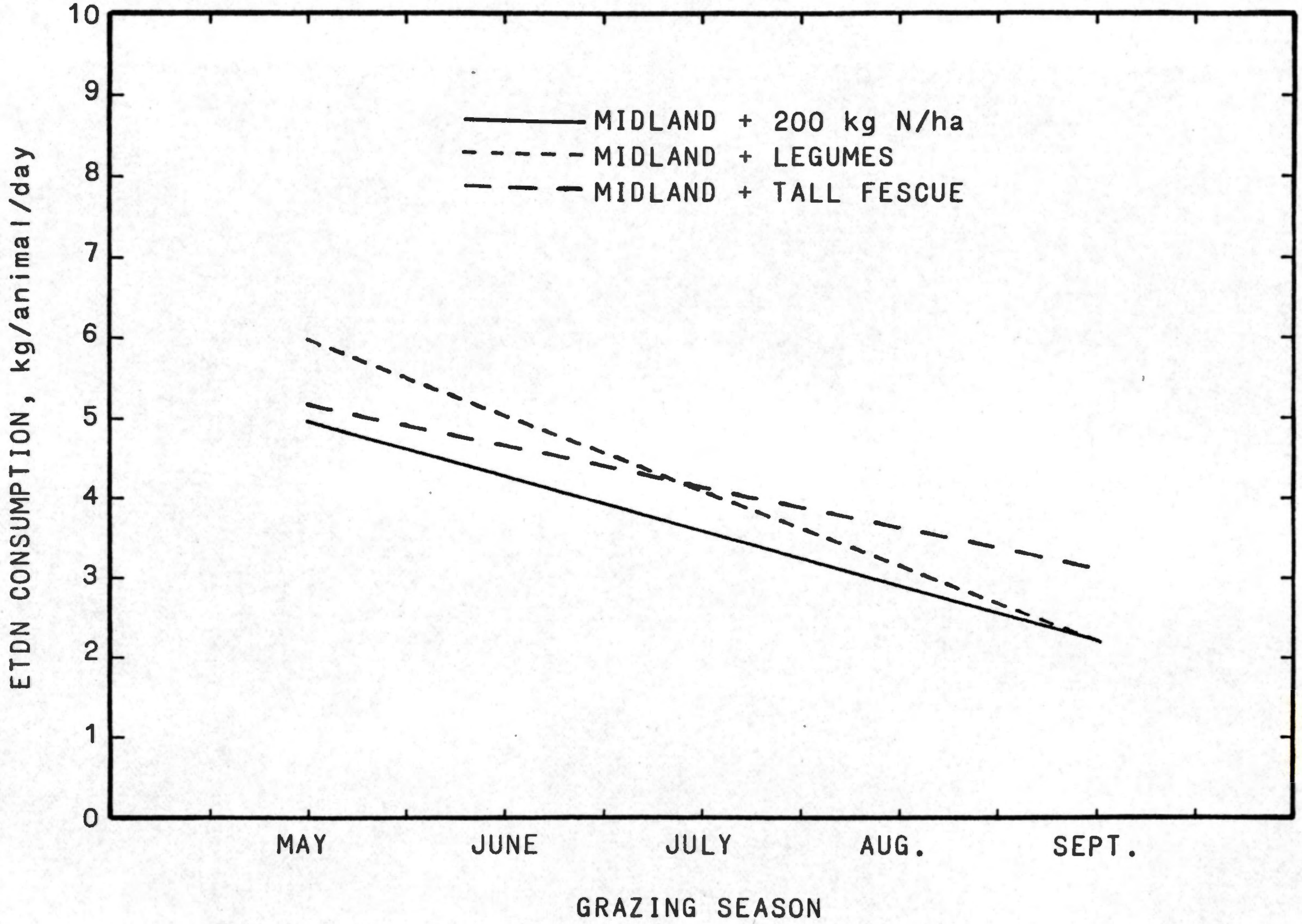

Figure 16. ETDN consumption from Midland bermudagrass fertilized with nitrogen or overseeded with either legumes or tall fescue.

+ legumes forage, it seemed that with the absence of legumes, the remaining forage would be less digestible. The percentage of ETDN in consumed Mid + legumes (Figure 7, page 36) was lower at the beginning of the grazing season than for either Mid + N or Mid + fescue. The amount of ETDN consumed was probably higher for Mid + legumes because more DM was consumed (Figure 13 and Table 4, pages 45 and 46).

Animals grazing fescue pastures consumed over 7 kg/day of ETDN on May 1. By late June, ETDN consumption from fescue became less than that from Mid + fescue pastures and remained less for the rest of the grazing season. ETDN content in consumed fescue forage was relatively constant during the season (Table 3, page 35), while consumed Mid + fescue forage increased steadily in %ETDN after July 1. However, ETDN consumption (kg/day) from these two pastures appeared to be more related to DM consumption than the %ETDN in the consumed forage (Figure 8, page 37; Figure 14, page 47; and Figure 17). A warm season perennial such as Midland, grown in association with a cool season perennial (fescue), usually furnishes a more even amount of ETDN throughout the grazing season.

Conversely, OG + clover was the only pasture in which animals slightly increased their ETDN consumption/day (Figure 18) as the season progressed. Coleman and Barth (1973) found that animals grazing OG + clover pastures selected forage higher in digestible dry matter. The increase, suggested here, began in mid-May and continued until July 1 (approximately 3.6 and 4 kg/day, respectively). Thereafter, animals grazing OG + clover pastures rapidly reduced ETDN consumption/day throughout July. However, Barth et al. (1972) reported an insignificant

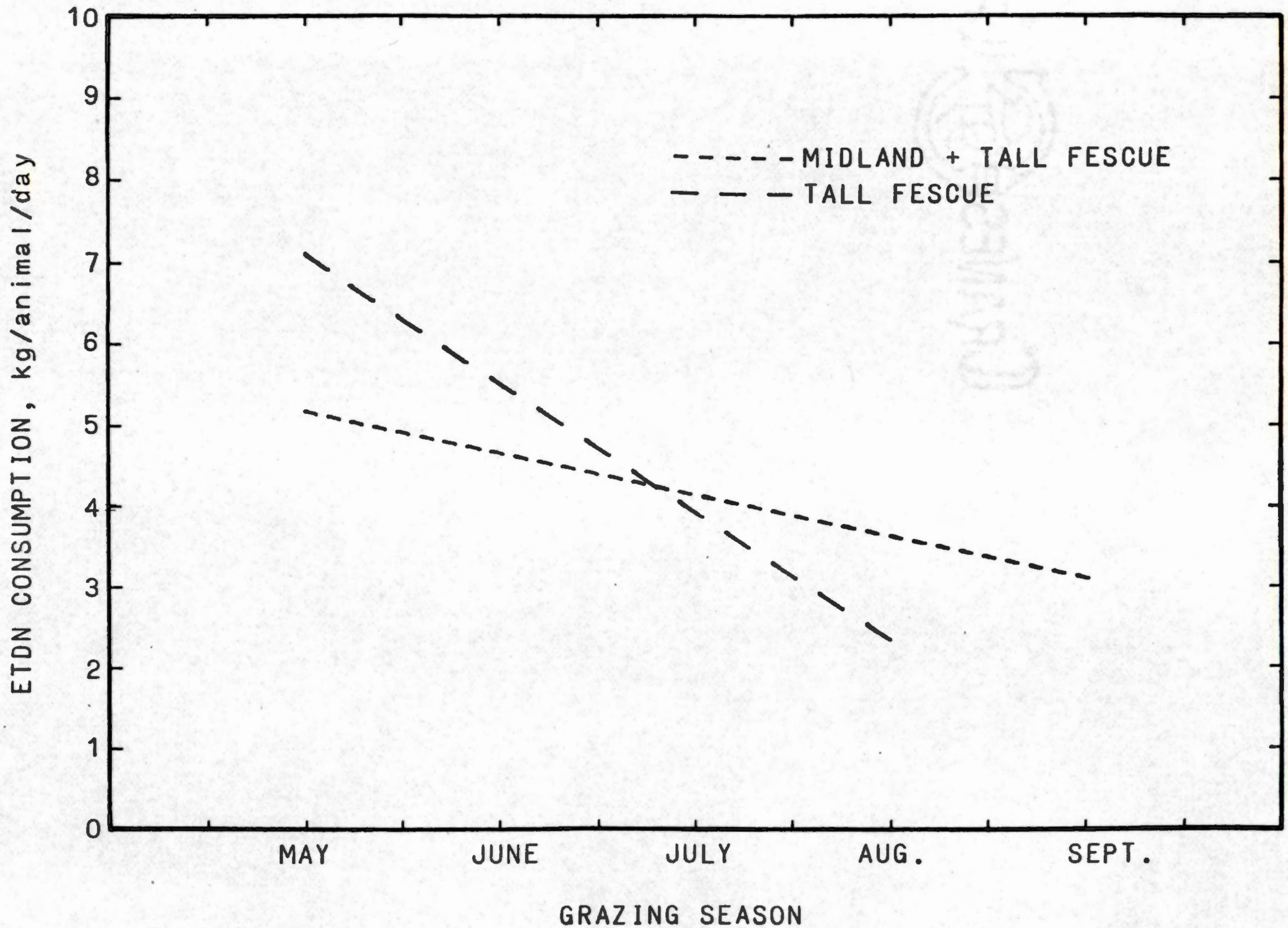

Figure 17. ETDN consumption from Midland bermudagrass overseeded with tall fescue and tall fescue alone.

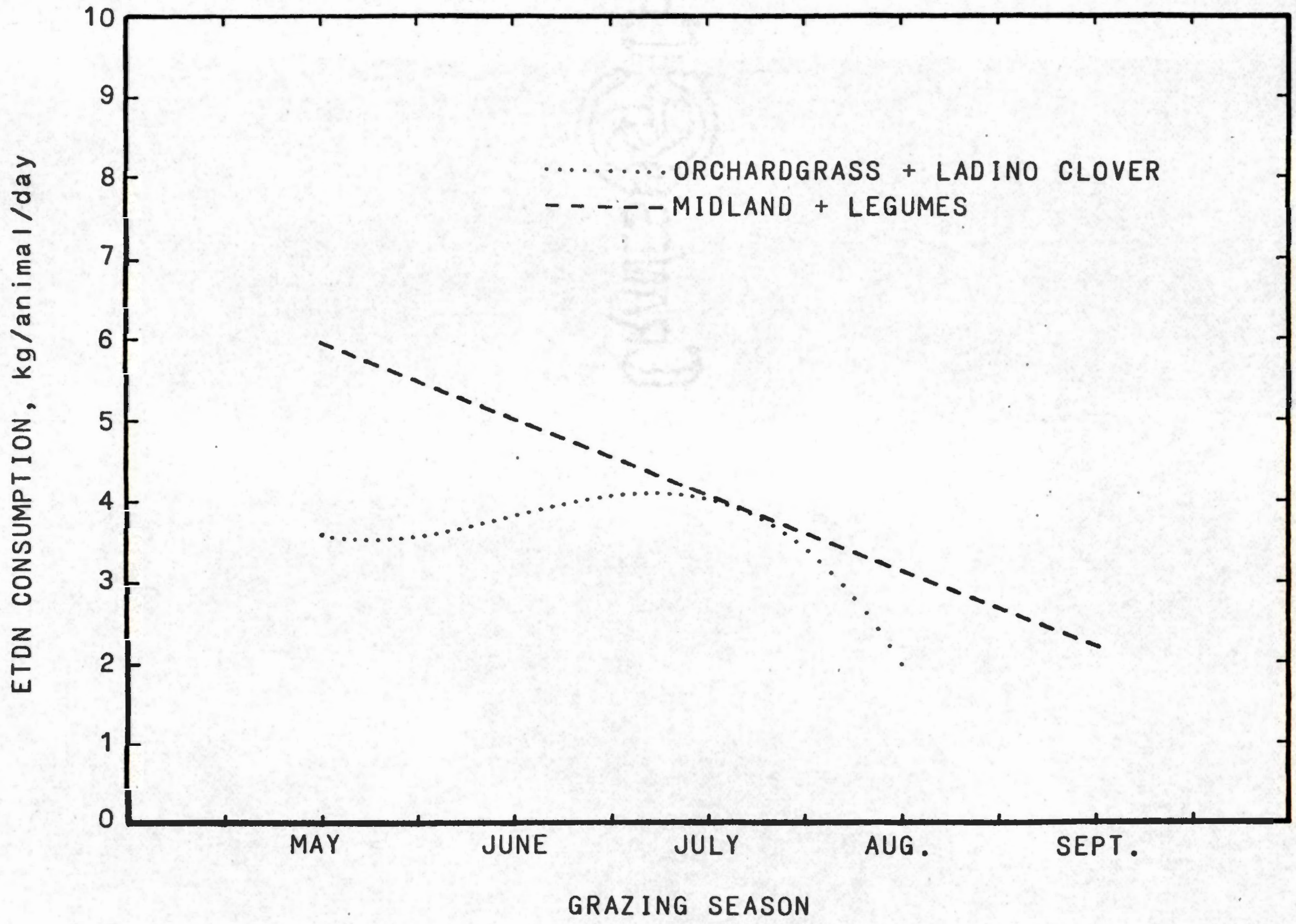

Figure 18. ETDN consumption from Midland bermudagrass overseeded with legumes and orchardgrass plus clover.

decrease in percentage digestible dry matter from OG + clover forage throughout the entire grazing season. It should be pointed out that Mid + legumes supported a higher level of ETDN consumption/day than OG + legumes for the entire season, except for a brief period in early July when the two pastures were equal in this category. It is possible that early in the grazing season, legumes comprised a large proportion of the total Mid + legumes forage. This might explain the wide difference in ETDN consumption within the two pastures at the beginning of the grazing season. Carver et al. (1978) reported that animals grazing OG + clover increased their ETDN consumption above maintenance up to early July. After May 22 animals grazing OG + clover consumed more ETDN above maintenance than Midland plus either 112, 224 or 448 kg N/hectare until late August.

Elapsed days of grazing had more effect on the amount of ETDN consumed from fescue and Mid + fescue pastures as evidenced by the R^2 values in Table 4, page 46. ETDN consumption from OG + clover pastures was least affected by elapsed days of grazing (R^2 = 0.20).

Crude Protein

At the beginning of the grazing season, CP consumption/day was quite variable among the three pastures that contained Midland (Figure 19). This variation almost disappeared by late May but reappeared in June for the remainder of the season. Animals grazing Mid + legumes consumed 1.51 kg CP/day (Table 4) on May 1 but decreased this CP consumption level steadily after that, probably because of a continuous selective grazing and eventual disappearance of legumes within

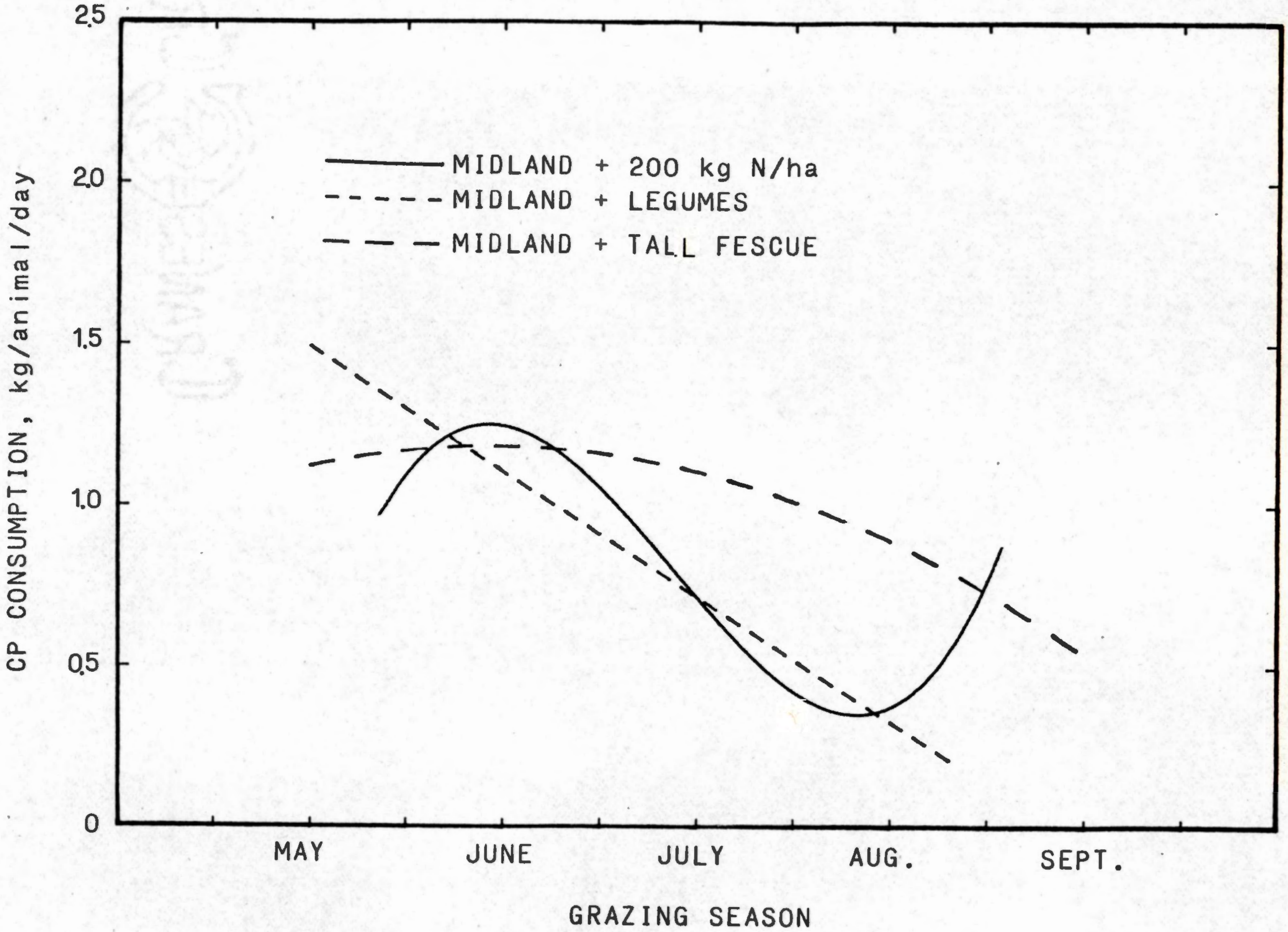

Figure 19. CP consumption from Midland bermudagrass fertilized with nitrogen or overseeded with either legumes or tall fescue.

the bermudagrass sod. There was also a uniform decrease throughout the grazing season in dry matter consumption and percent CP in the consumed forage, both of which perhaps influenced the CP consumption/day. CP intake from Mid + fescue pastures increased very slightly from 1.12 kg CP/day on May 1 to 1.20 kg CP/day in the first week in June but decreased at a progressive rate until September 1. The marked increase in percent CP in consumed forage, illustrated in Figure 10 (page 40), appeared to have only a slight effect on consumption. DM consumption affected CP consumption to a greater extent than did percent CP. Animals grazing Mid + N demonstrated a rapid increase in CP consumption/day the latter part of May. A rapid decrease was noted in CP consumption/day until late July, at which time animals again increased their CP intake drastically, much like the trends in DM consumption (Figure 13, page 45).

When fescue and Mid + fescue pastures were compared (Figure 20) for CP consumption/day, the greatest difference (1.57 and 1.12 kg/day, respectively) appeared on the first day of the season. The early season variation was due to the fact that there was probably more DM and CP available to the animals. This difference diminished steadily until July and varied little thereafter.

Animals grazing OG + clover increased their CP consumption/day for approximately the first two months of the grazing season (Figure 21) while Mid + legumes pastures were continuously decreasing. The increase in daily CP consumption from OG + clover pasture could be due to both percent CP in consumed forage (Figure 12, page 43) and DM consumption (Figure 15, page 49). However, throughout July the tester steers

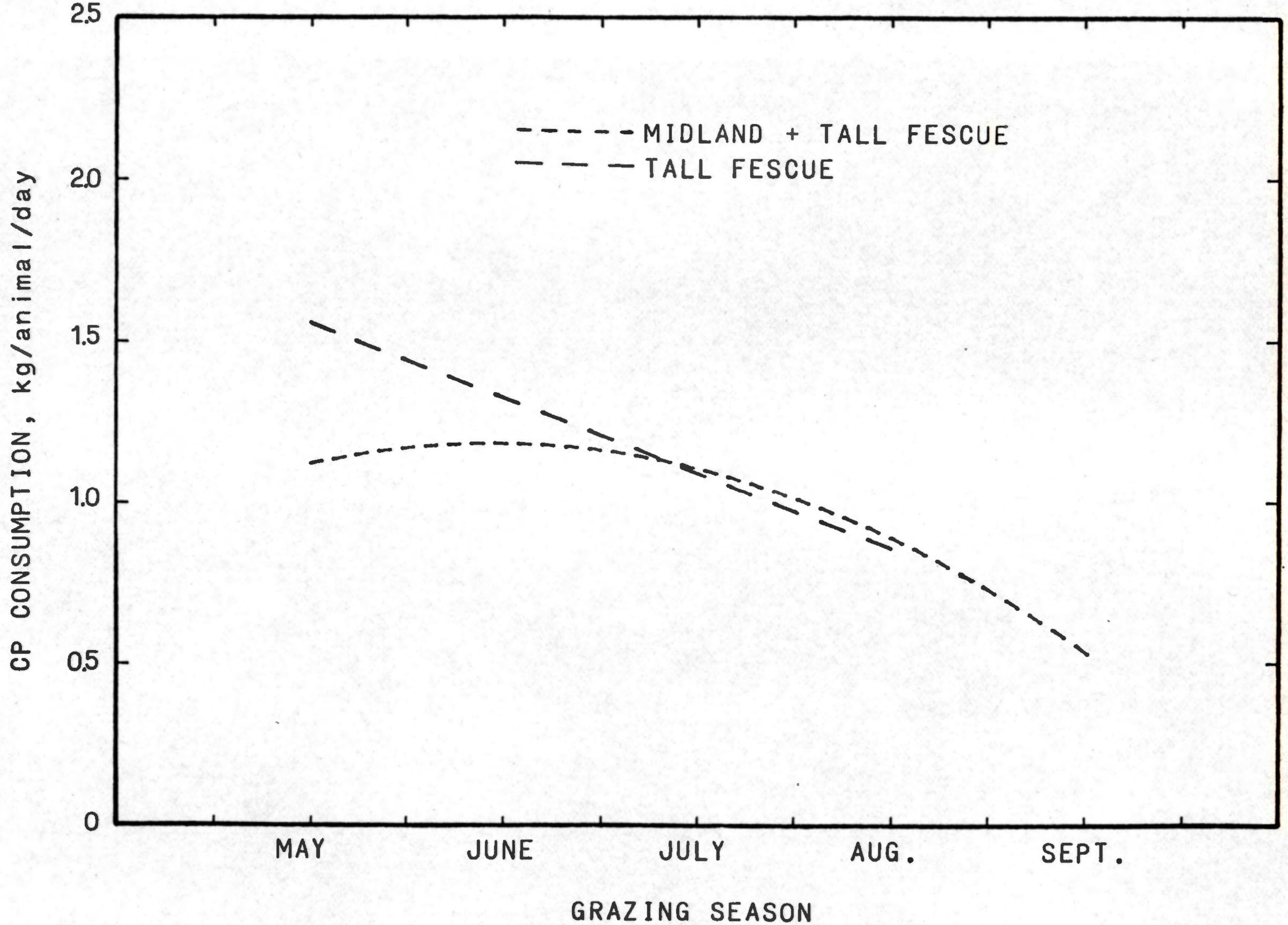

Figure 20. CP consumption from Midland bermudagrass overseeded with tall fescue and tall fescue alone.

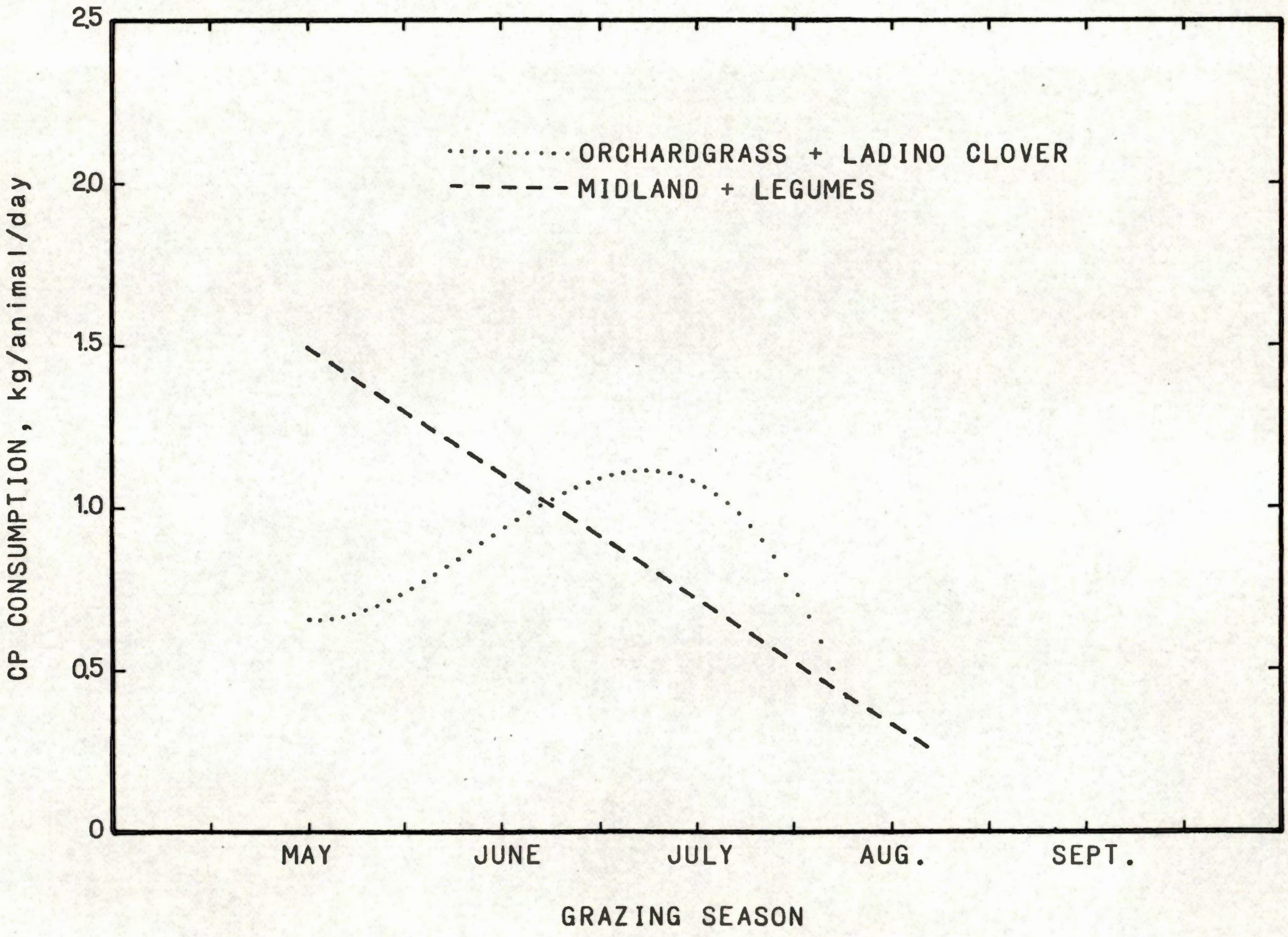

Figure 21. CP consumption from Midland bermudagrass overseeded with legumes and orchardgrass plus clover.

consuming OG + clover were rapidly declining in CP intake/day, due to the onset of the hot summer months and eventual dormancy of OG + clover.

The R^2 values suggest that the change in CP consumption from Mid + N pastures was most dependent on the days of the growing season (Table 4, page 46). Elapsed days of grazing affected least the CP consumption from OG + clover pastures (R^2 = 0.32).

Amount of Intake above Maintenance

Estimated Total Digestible Nutrients

In Figure 22, 23 and 24 the effect of elapsed days of grazing on ETDN intake above maintenance is shown. Animals grazing pastures comprised either partially or fully of Midland consumed more ETDN above maintenance on May 1 than at any other time during the grazing season (Table 5), and the steers continued to decrease their ETDN consumption, at various rates, throughout the season.

At the beginning of the season, animals had substantially more ETDN intake above maintenance from fescue pastures than from Mid + fescue pastures (4.58 and 2.77 kg/day, respectively). However, ETDN consumption from fescue pastures decreased rapidly and by late June was below ETDN consumption from Mid + fescue. Tester steers grazing OG + clover increased slightly their ETDN intake above maintenance from mid-June to July 1 but decreased it quickly thereafter; thus, ETDN consumption from OG + clover was never greater than consumption from Mid + legumes.

The coefficients of determination for ETDN consumption above maintenance were quite similar to the coefficients for ETDN consumption.

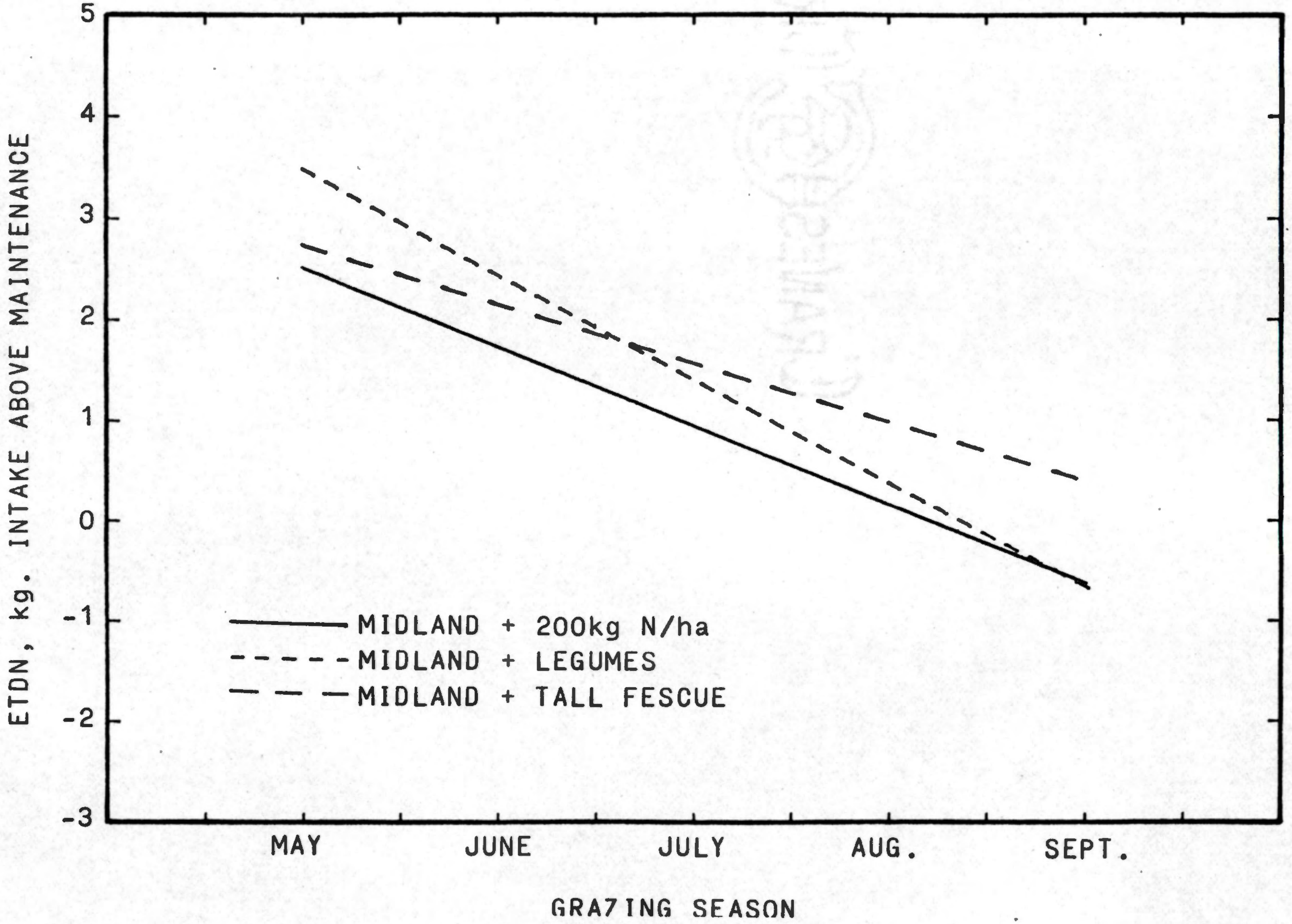

Figure 22. ETDN intake above maintenance from Midland bermudagrass fertilized with nitrogen and overseeded with either legumes or tall fescue.

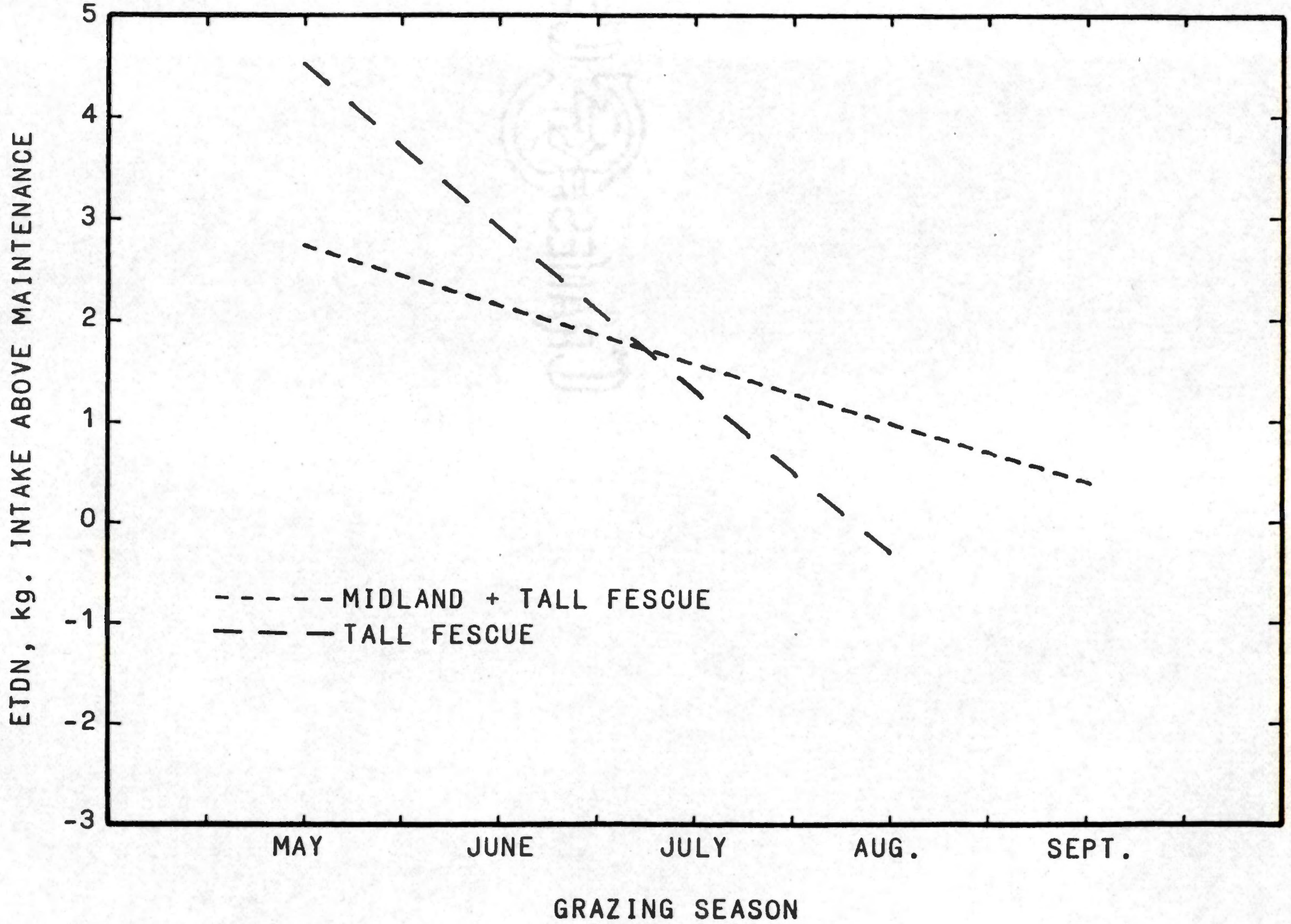

Figure 23. ETDN intake above maintenance from Midland bermudagrass overseeded with tall fescue and tall fescue alone.

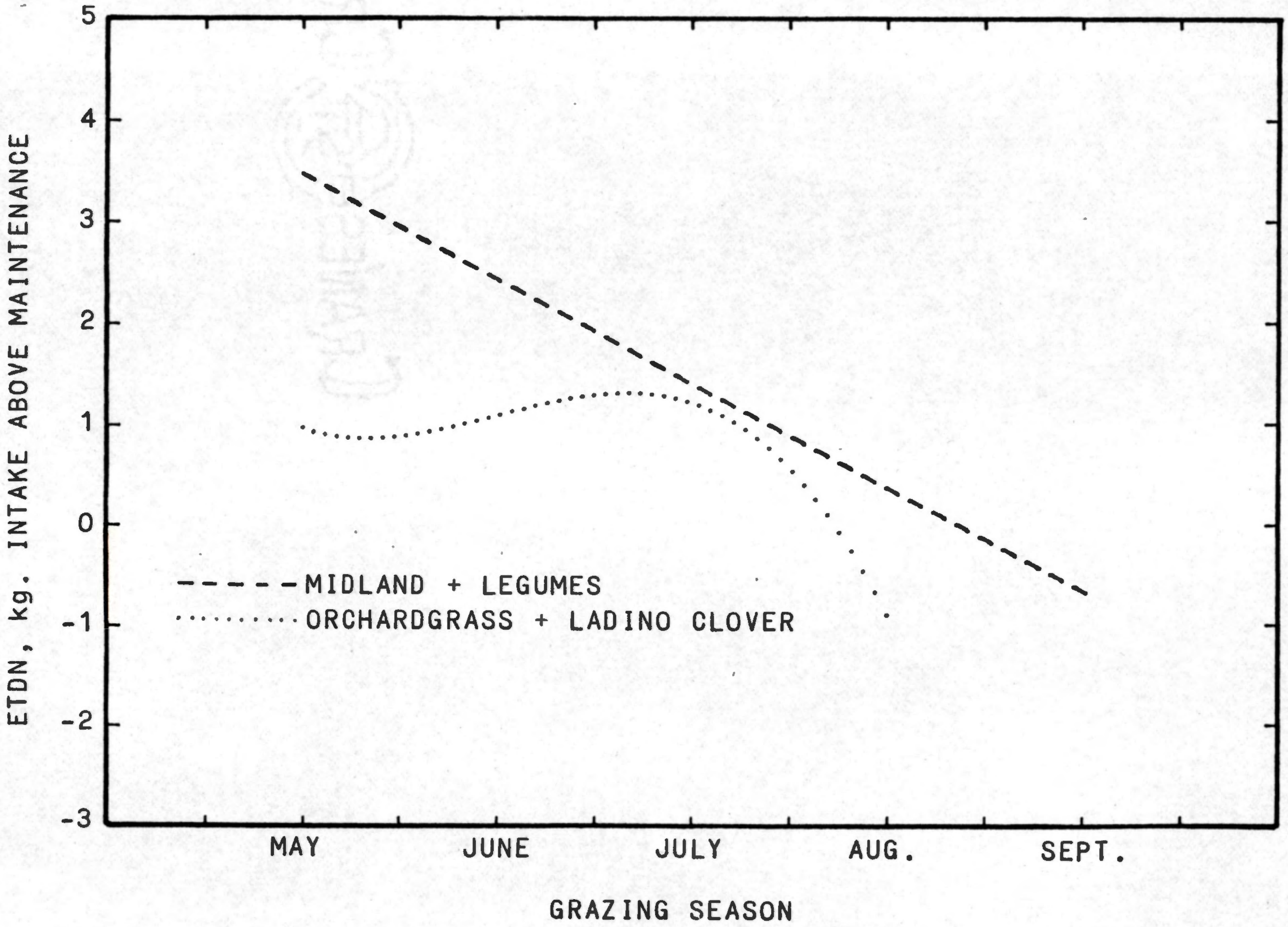

Figure 24. ETDN intake above maintenance from Midland bermudagrass overseeded with legumes and orchardgrass plus clover.

TABLE 5. PREDICTED MONTHLY CHANGES IN CONSUMPTION ABOVE MAINTENANCE

Date	Elapsed days of grazing	Pasture treatments: Midland + 200 kg N/ha	Midland + legumes	Midland + tall fescue	Tall fescue	Orchardgrass + ladino clover
Estimated total digestible nutrients consumption, kg/day						
May 1	35	2.55	3.51	2.77	4.58	0.99
June 1	66	1.74	2.45	2.16	2.92	1.09
July 1	96	0.95	1.41	1.58	1.31	1.22
Aug. 1	127	0.14	0.35	0.97	-0.34	-1.03
Sept. 1	158	-0.67	-0.72	0.37	—	—
R^2		0.36[a]	0.25[a]	0.49[a]	0.58[a]	0.18[a]
Crude protein consumption, kg/day						
May 1	35	-0.04	1.10	0.72	1.15	0.23
June 1	66	0.83	0.68	0.77	0.90	0.48
July 1	96	0.28	0.28	0.69	0.67	0.61
Aug. 1	127	-0.05	-0.13	0.45	0.42	-0.57
Sept. 1	158	—	-0.55	0.08	—	—
R^2		0.63[a]	0.44[a]	0.43[a]	0.49[a]	0.32[a]

[a]Fraction of the variation in the original data in each response variable that was explained by elapsed days of grazing.

Elapsed days of grazing explained from 18 to 58% of the variability in ETDN consumption above maintenance (Table 5).

Crude Protein

On May 1 (Figure 25) steers grazing Mid + legumes consumed more CP above maintenance than either Mid + fescue or Mid + N (1.10 kg/day, 0.72 kg/day and -0.04 kg/day, respectively). Animal intake of CP above maintenance, however, did decrease for Mid + legumes for the remainder of the grazing season, while animals grazing Mid + fescue increased CP intake slightly through the first week in June with a gradual decrease after that time. Steers grazing Mid + N pastures demonstrated a substantial increase in CP intake above maintenance through May, but CP consumption decreased from June 1 to late July followed by a rapid increase in August.

Animals grazing fescue pastures consumed 0.43 kg/day more CP above maintenance on May 1 than steers grazing Mid + fescue. This intake difference in CP had vanished by mid-June (Figure 26) and it was essentially nil for the rest of the grazing season.

Animals grazing OG + clover increased their CP intake above maintenance from May 1 to mid-June (Figure 27) with a rapid decrease thereafter. Conversely, steers on Mid + legumes decreased CP consumption from the beginning to the end of the grazing season.

The R^2 values for CP consumption above maintenance were also quite similar to the R^2 values for CP consumption. Elapsed days of grazing affected greatly the CP consumption above maintenance of steers on Mid + N ($R^2 = 0.63$).

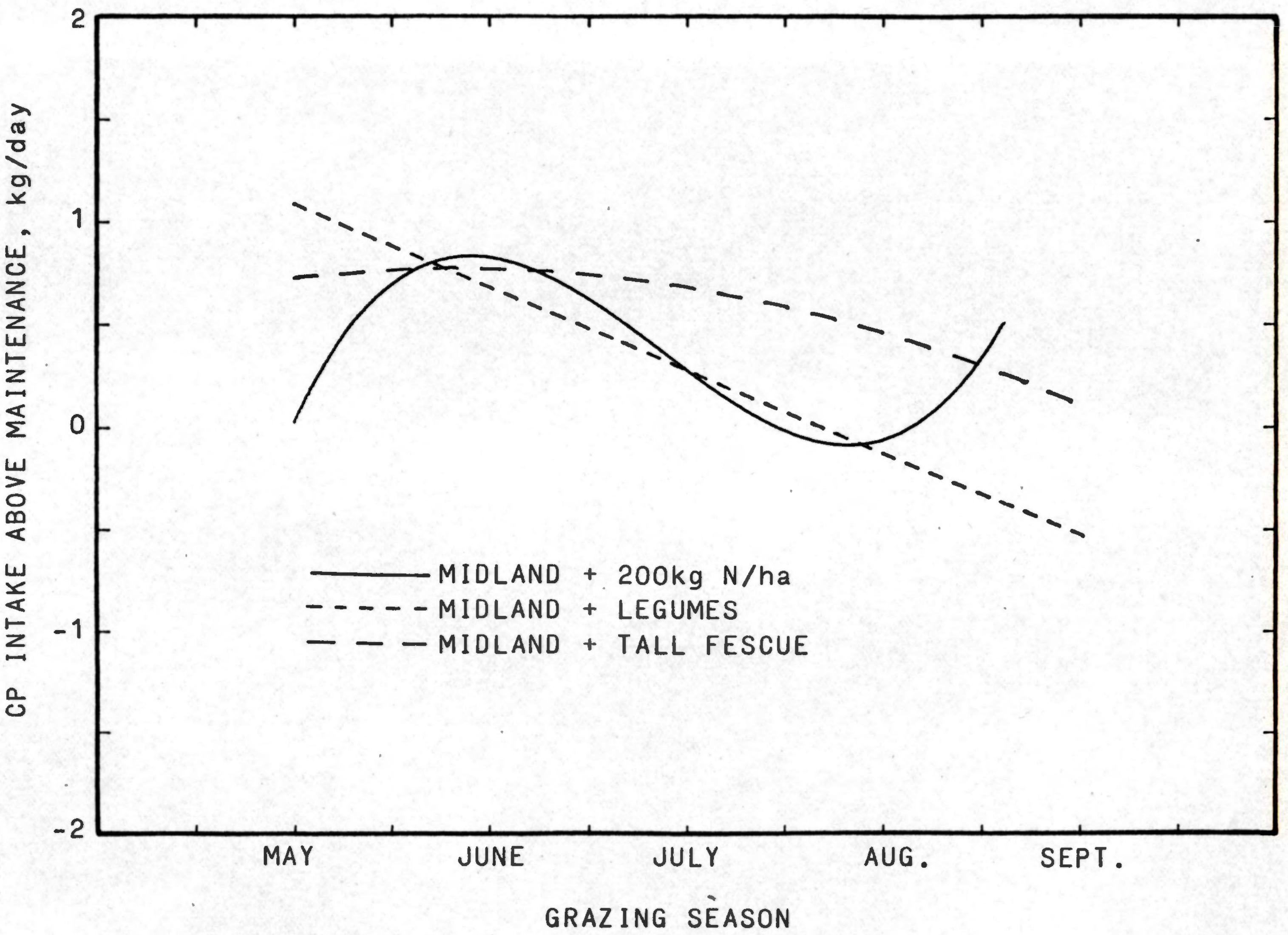

Figure 25. CP intake above maintenance from Midland bermudagrass fertilized with nitrogen or overseeded with either legumes or tall fescue.

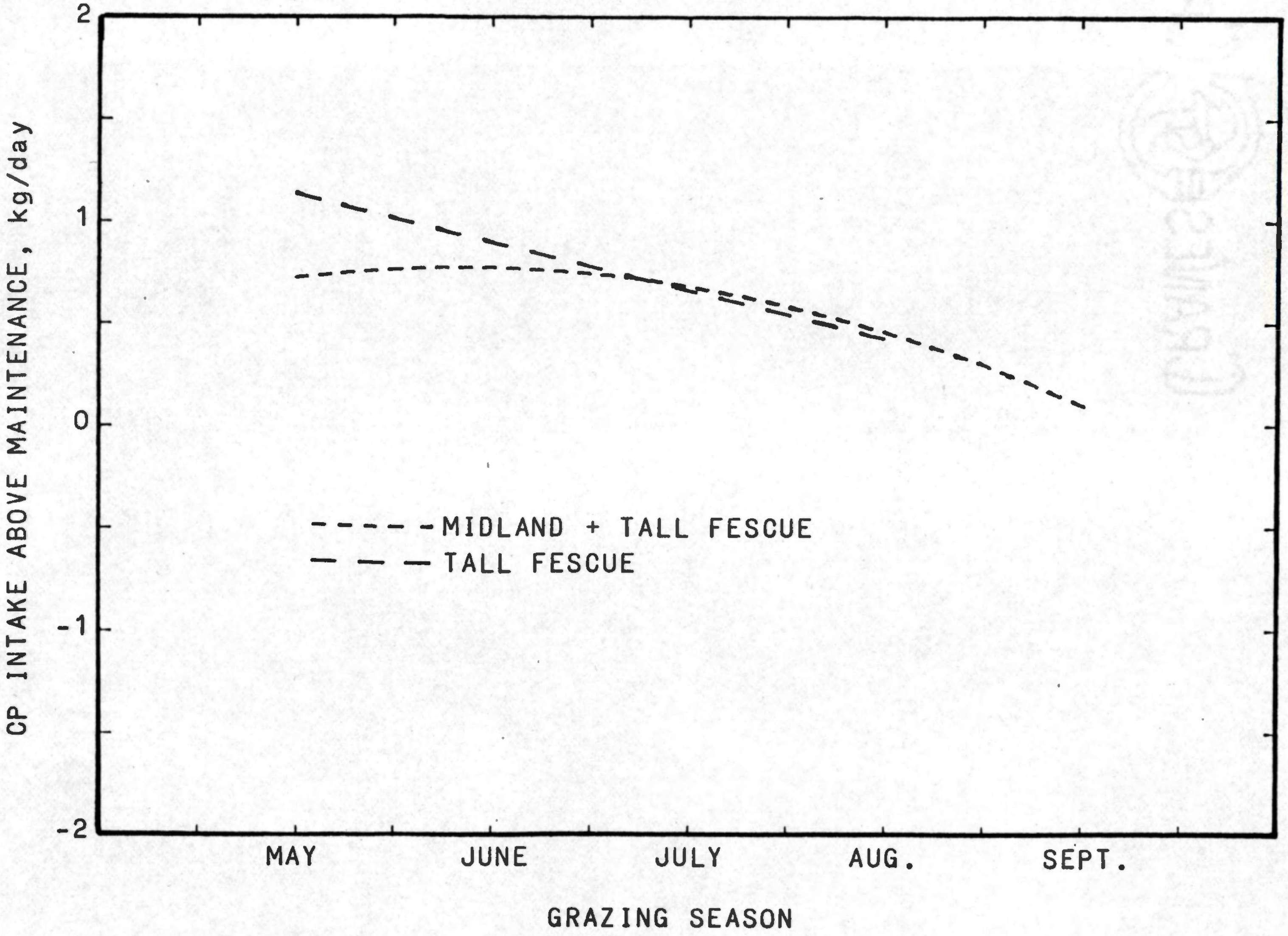

Figure 26. CP intake above maintenance from Midland bermudagrass overseeded with tall fescue and tall fescue alone.

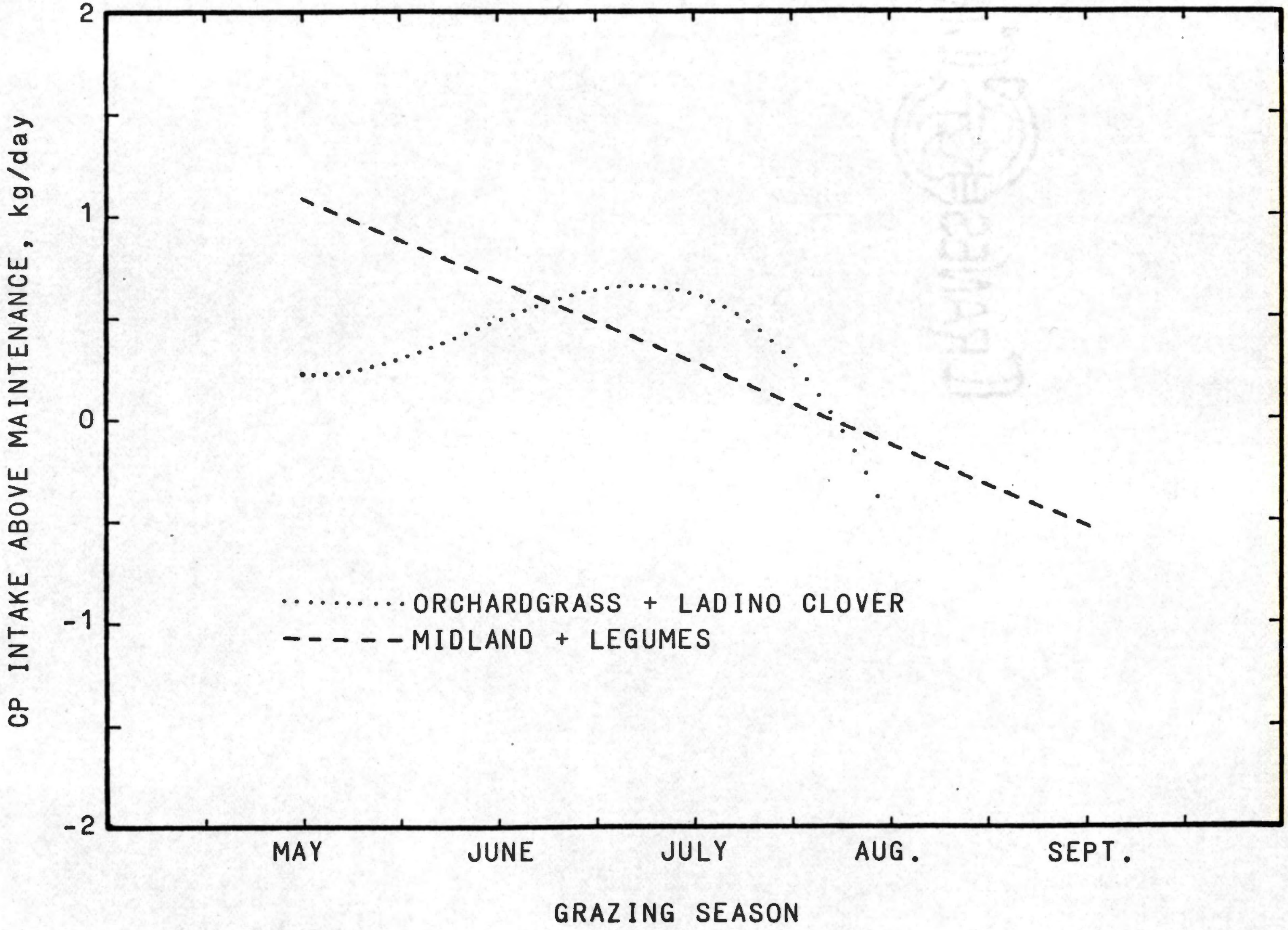

Figure 27. CP intake above maintenance from Midland bermudagrass overseeded with legumes and orchardgrass plus clover.

Amount of Intake per Unit Metabolic Weight

Estimated Total Digestible Nutrients

Animals grazing pastures that contained Midland consumed less per unit metabolic weight in May and June than did animals grazing fescue pastures (Table 6). On July 1, however, steers grazing fescue were consuming approximately the same ETDN per unit metabolic weight as were steers grazing pastures with Midland. By August 1, steers grazing fescue pastures consumed considerably less ETDN per unit metabolic weight than steers grazing most Midland pastures.

Steers grazing OG + clover consumed less ETDN per unit metabolic weight throughout the season than those grazing either fescue or the various Midland pastures. However, the constant decrease in ETDN consumption observed in the other pastures was not observed in OG + clover pastures until after July 1.

As in the other ETDN consumption variables, the ETDN consumed per unit metabolic weight was most affected by elapsed days of grazing in the fescue treatment (Table 6). ETDN consumption per unit metabolic weight was least affected by elapsed days of grazing in the OG + clover treatment (R^2 = 0.16).

Crude Protein

Monthly values are presented in Table 6. Steers grazing Mid + legumes, Mid + fescue and fescue pastures consumed more CP per unit metabolic weight on May 1 than at any other time in the grazing season. CP intake after May 1 decreased steadily for Mid + fescue and fescue pastures, but decreased more rapidly for Mid + legumes. Animals grazing

TABLE 6. PREDICTED MONTHLY CHANGES IN CONSUMPTION PER UNIT METABOLIC WEIGHT

		Pasture treatments				
Date	Elapsed days of grazing	Midland + 200 kg N/ha	Midland + legumes	Midland + tall fescue	Tall fescue	Orchardgrass + ladino clover
Estimated total digestible nutrients consumption, grams/day						
May 1	35	72.9	86.2	77.3	105.1	49.6
June 1	66	61.0	70.2	68.0	79.3	49.2
July 1	96	49.6	54.7	59.0	54.5	48.6
Aug. 1	127	37.7	38.7	49.8	28.7	12.9
Sept. 1	158	25.8	22.6	40.5	—	—
R^2		0.37[a]	0.28[a]	0.48[a]	0.58[a]	0.16[a]
Crude protein consumption, grams/day						
May 1	35	6.2	22.0	16.5	22.5	9.1
June 1	66	16.4	15.6	15.3	18.7	13.5
July 1	96	5.9	9.5	14.0	15.1	17.8
Aug. 1	127	3.5	3.1	12.7	11.3	6.8
Sept. 1	158	11.6	-3.3	11.5	—	—
R^2		0.64[a]	0.45[a]	0.40[a]	0.49[a]	0.30[a]

[a]Fraction of the variation in the original data in each response variable that was explained by elapsed days of grazing.

Mid + N and OG + clover pastures increased their CP intake per unit of metabolic body weight until June and July, respectively. CP consumption per unit metabolic weight had declined considerably by August for these two pastures. However, steers grazing Mid + N increased CP intake per unit metabolic weight from 3.5 g/day on August 1 to 11.6 g/day on September 1.

Elapsed days of grazing had the most effect on the CP consumption per unit metabolic weight from Mid + N pastures ($R^2 = 0.64$). The prediction equations explained from 30 to 49% of the variability in CP consumption per unit metabolic weight from the other treatments (Table 6).

Average Daily Gain

ETDN composition of the available pasture forage (Table 2, page 24) appeared to be positively correlated with ADG, while the CP percentage seemed to be less related with ADG. Steer gains decreased throughout the grazing season for the pastures containing Midland, as did ETDN. Animals grazing fescue and OG + clover also gained less as the season progressed, with a slight increase at the end of the season. This trend was again illustrated in the ETDN content of the available forage.

The ADG of the steers grazing fescue and OG + clover was affected more by elapsed days of grazing ($R^2 = 0.79$ and 0.76, respectively) than was that of the Midland treatments (Table 7).

Comparison of ADG and Composition of Consumed Forage

Theoretically, animal gains should be more closely related to the nutritive value of consumed forage than to that of available forage. This appeared to be the case with regard to the Mid + N pastures, with

TABLE 7. PREDICTED MONTHLY AVERAGE DAILY GAIN

		Pasture treatments				
Date[a]	Elapsed days of grazing	Midland + 200 kg N/ha	Midland + legumes	Midland + tall fescue	Tall fescue	Orchardgrass + ladino clover
		Average daily gain, kg/day				
May 1	35	1.01	1.15	0.80	0.91	1.42
June 1	66	0.75	0.86	0.54	0.25	0.45
July 1	96	0.49	0.58	0.29	-0.03	—
Aug. 1	127	0.23	0.29	0.02	0.04	0.04
Sept. 1	158	-0.02	0.01	-0.24	—	—
R^2		0.60[b]	0.42[b]	0.52[b]	0.79[b]	0.76[b]

[a]Mean date of each period.

[b]Fraction of the variation in the original data in each response variable that was explained by elapsed days of grazing.

a more rapid decline in %ETDN of consumed forage in relation to the rapid decline in ADG. However, animals grazing fescue consumed forage essentially constant in %ETDN, while ADG decreased quickly over the entire grazing season. The quality of consumed Mid + legumes decreased about 6% (53.8% on May 1 to 48% on September 1), but ADG decreased from 1.15 kg/day to 0.01 kg/day (Table 7). Steers grazing Mid + fescue and OG + clover consumed a higher quality forage on September 1 and August 1, respectively, than at any other time of the season (Table 3, page 35). This increase in nutritive value had no effect on the gains from Mid + fescue and only slightly increased the ADG of animals grazing OG + clover.

Consumed Mid + N and Mid + legume forage decreased in %CP throughout the grazing season as did the gains of the animals grazing those pastures. However, the steers selected Mid + fescue, fescue and OG + clover forage that was highest in %CP in the middle of the grazing season, although ADG was decreasing at that time.

Comparison between ADG and Amount of Consumed Forage

The amount of DM, ETDN and CP consumed per day was calculated and is presented on Table 4, page 46. The quantity of ETDN and CP consumed above maintenance and consumed per unit of metabolic weight appear in Tables 5 and 6, pages 63 and 69, respectively.

For the most part, ADG seemed to be most closely related to the consumption of ETDN and less related to CP and DM consumption. Carver (1975) found low and insignificant correlations between ADG and the amount of forage nutrients consumed.

CHAPTER V

SUMMARY

Midland bermudagrass pastures consisting of Midland bermudagrass or Midland in combination with either tall fescue or legumes were compared to each other and to orchardgrass-clover or tall fescue pastures. The cage-and-strip method was used to determine forage consumption from the beginning of May until the beginning of September during 1975, 1976 and 1977. Yearling beef steers acquired from fall feeder calf sales and weighing an average of approximately 215 kg were used in a put-and-take grazing system. Tester steers were weighed at about 21-day intervals to determine rate of gain. All forage samples were assayed for total N and *in vitro* digestible dry matter (IVDDM). Estimated total digestible nutrients (ETDN) was calculated from IVDDM.

Three years of forage composition and intake data were reduced to polynomial equations describing the regression of ETDN and crude protein (CP) content and the intake of ETDN and CP, on elapsed days of grazing. The regression equations were used to generate predicted percentages of ETDN and CP and consumption of ETDN and CP at monthly intervals beginning on May 1 and extending to September 1.

The available forage of all the pastures decreased in ETDN content during the month of May with Mid + N and Mid + legumes forage exhibiting this decline throughout the grazing season. The %ETDN in available Mid + fescue, fescue and OG + clover changed little from June until pasture grazing was terminated.

Available Mid + legumes was the only pasture forage to increase in %CP from the beginning of the season, while all other pastures decreased in %CP. However, the decline of %CP in available Mid + N, Mid + fescue, fescue and OG + clover ended during early summer and began to increase. Only the pastures containing Midland forage decreased in CP content in late summer.

Consumed Mid + N, Mid + legumes, Mid + fescue and OG + clover forage decreased in ETDN content during May, with Mid + N and Mid + legumes continuing this trend throughout the season. Consumed Mid + fescue and OG + clover increased in %ETDN from July 1 until the animals were taken off. Fescue varied little in the ETDN content of consumed forage.

The %CP in consumed Mid + N and Mid + legumes decreased at about the same rate from May 1 to September 1. Consumed Mid + fescue, fescue and OG + clover increased in %CP throughout May. The CP content of consumed Mid + fescue and OG + clover were decreasing at season's end, while consumed fescue forage increased in %CP for the entire season.

Animals grazing Mid + fescue and Mid + legumes decreased their DM consumption/day for the entire season with Mid + legumes being consumed at a higher level in the beginning. Only in late spring and late August was Mid + N consumed at a greater level than either of the other two Midland treatments. Fescue DM consumption decreased steadily from May 1 to August 1, while OG + clover forage consumption increased from mid-May until late June preceded by a dramatic decrease.

Steer ETDN consumption/day decreased continuously from the beginning for all treatments except OG + clover which increased slowly from mid-May to mid-June followed by a significant decrease through July.

Fescue pastures allowed steers to consume levels of CP that were comparable to Mid + legumes without as rapid a decline, while steers on OG + clover increased CP consumption steadily until July when consumption levels decreased drastically.

Intake above maintenance data followed the same trends as consumption data.

Steer ETDN consumption per unit metabolic weight (gm/day) decreased throughout the season for all treatments.

Steers grazing Mid + legumes, Mid + fescue and fescue decreased their CP intake per unit metabolic weight by 25.3, 5 and 11.2 gm/day, respectively, over the course of the grazing season. Mid + N and OG + clover provided more CP consumption in late spring (16.4 gm/day) and early summer (17.8 gm/day, respectively) than any other time.

ETDN composition of available forage appeared to be more related to ADG than did CP composition. ADG did not appear to be related to the composition of consumed forage except for Mid + N pastures that demonstrated a rapid decline in both variables. ADG seemed to be most closely related to the consumption of ETDN and less related to CP and DM consumption.

BIBLIOGRAPHY

BIBLIOGRAPHY

Barth, K. M., J. B. McLaren and C. D. Lane. 1972. Monthly changes in chemical composition and digestibility of orchardgrass-clover and fescue-lespedeza pasture forage. Tenn. Agr. Exp. Stat. Bul. 500.

Blaser, R. E. 1964. Symposium on forage utilization: Effects of fertility levels and stage of maturity on forage nutritive value. J. Anim. Sci. 23:246.

Blaser, R. E., R. C. Hammes, Jr., H. T. Bryant, C. M. Kincaid, W. H. Skrdla, T. H. Taylor and W. L. Griffith. 1956. The value of forage species and mixtures for fattening steers. Agron. J. 48:508.

Burns, J. C., L. Goode, H. D. Gross and A. C. Linnerud. 1973. Cow and calf gains on ladino clover-tall fescue and tall fescue, grazed alone and with Coastal bermudagrass. Agron. J. 65:877.

Burton, G. W. 1966. Bermudagrass. In H. D. Hughs, M. E. Heath and D. S. Metcalfe (Ed.) Forages. The Iowa State University Press, Iowa.

Burton, G. W., J. E. Jackson, and R. H. Hart. 1963. Effects of cutting frequency and nitrogen on yield, in vitro digestibility and protein, fiber, and carotene content of Coastal bermudagrass. Agron. J. 55:500.

Carver, L. A. 1975. Effect of nitrogen fertilization on nutritive value of Midland bermudagrass pastures for yearling beef cattle. Ph.D. dissertation, University of Tennessee.

Carver, L. A., K. M. Barth, J. B. McLaren, H. A. Fribourg, J. T. Connell and J. M. Bryan. 1978. Total digestible nutrient content of consumed forage and total digestible nutrient consumption by yearling beef steers grazing nitrogen-fertilized bermudagrass and orchardgrass-ladino clover pastures. J. Anim. Sci. 47:699.

Decker, A. M., H. J. Retzer and F. R. Dudley. 1974. Cool season perennials versus cool season annuals sod seeded into a bermudagrass sward. Agron. J. 66:381.

Decker, A. M., R. W. Hemkin, J. R. Miller, N. A. Clark and A. V. Okorie. 1971. Nitrogen fertilization, harvest management, and utilization of "Midland" bermudagrass. (Cynodon dactylon {L.} pers.) Md. Agr. Exp. Sta. Bul. 487.

Decker, A. M., H. J. Retzer, F. G. Swain and R. F. Dudley. 1969. Midland bermudagrass forage production supplemented by sod seeded cool season annual forages. Md. Agr. Exp. Sta. Bul. 484.

Elder, W. C. and H. F. Murphy. 1961. Grazing characteristics and clipping responses of bermudagrass. Okla. Agr. Exp. Sta. Bul. 577.

Fribourg, H. A., J. B. McLaren, K. M. Barth, J. M. Bryan and J. T. Connell. 1979. Productivity and quality of bermudagrass and orchardgrass-ladino clover pastures for beef. Agron. J. 71:315.

Fribourg, H. A. and J. R. Overton. 1973. Forage production on bermudagrass sods overseeded with tall fescue and winter annual grasses. Agron. J. 65:295.

Fribourg, Henry A., Ned C. Edwards, Jr., and Karl M. Barth. 1971. In vitro dry matter digestibility of "Midland" bermudagrass grown at several levels of N fertilization. Agron. J. 63:786.

Fribourg, H. A. 1963. Performance of some forage crop varieties, 1945-1962. Tenn. Agr. Exp. Sta. Bul. 371.

Hallock, D. L., R. H. Brown and R. E. Blaser. 1966. Response of Coastal and Midland bermudagrass and Ky. 31 fescue to nitrogen in southeastern Virginia. Va. Polytech Inst. and State Univ. Res. Div. Res. Rep. 112.

Hallock, D. L., R. H. Brown and R. E. Blaser. 1965. Relative yield and composition of Ky. 31 fescue and Coastal bermudagrass at four nitrogen levels. Agron. J. 57:539.

Harlan, J. R., G. W. Burton and W. C. Elder. 1954. Midland bermudagrass. A new variety for Oklahoma pastures. Okla. Agr. Exp. Sta. Bul. B-416.

Harris, R. R., E. M. Evans, J. K. Boseck and W. B. Webster. 1972. Fescue, orchardgrass and "Coastal" bermudagrass grazing for yearling beef steers. Ala. Agr. Exp. Sta. Bul. 432.

Heaney, D. P., and W. J. Pigden. 1963. Interrelationships and conversion factors between expressions of the digestible energy value of forages. J. Anim. Sci. 22:956.

Holt, E. C. and J. A. Lancaster. 1968. Bermudagrass production and management in east Texas. Texas Agr. Exp. Sta. Bul. 1073.

Holt, E. C., J. A. Lancaster and M. Buckingham. 1961. Bermudagrass production in northeast Texas. Texas Agr. Exp. Sta. MP-548.

Hopkinson, D. 1970. The potential of some pasture plants in the sisal areas of the Tanga region of Tanzania. E. Afr. Agr. For. J. 35:299.

Horn, F. P., C. M. Taliaferro, J. Muncrief and K. W. Williams. 1974. Effects of nitrogen fertilizer rate and clipping frequency on the yield and quality of four bermudagrasses. O.S.U. Agr. Exp. Sta. Misc. Publ. U.S.D.A. 92:89.

Hoveland, C. S. 1960. Bermudagrass for forage in Alabama. Ala. Agr. Exp. Sta. Bul. 328.

Kresge, C. B. and A. M. Decker. 1965. Nutrient balance in Midland bermudagrass as affected by differential N and K fertilization. 1. Forage yields and persistence. Int. Grassland Cong., Proc. IX, p. 671.

Knight, W. E. 1970. Productivity of crimson and arrowleaf clovers grown in a "Coastal" bermudagrass sod. Agron. J. 62:773.

Knight, W. E. 1967. Effect of seeding rate, fall disking and nitrogen level on stand establishment of crimson clover in a grass sod. Agron. J. 59:33.

Malm, N. R., C. E. Barnes and W. J. Russell. 1970. Forage production of bermudagrass alone and mixed with alfalfa or hairy vetch in the Pecos Valley. New Mexico Agr. Exp. Sta. Res. Rep. 182.

McMurphy, W. E. and B. B. Tucker. 1975. Midland bermudagrass pasture research. Okla. Agr. Exp. Sta. Res. Rep. P-715.

National Research Council. 1970. Nutrient Requirements of Beef Cattle. 4th ed. National Academy of Science, Washington, D.C.

Robison, G. D. and E. H. Jensen. 1967. Bermudagrass for forage. Nev. Ranch and Home Rev. 3:10.

Spooner, A. E. and M. L. Ray. 1974. Influence of timing of nitrogen application on pastures and on performance of beef cattle. Ark. Agr. Exp. Sta. Bul. 791.

Telford, J. P., F. P. Horn, J. E. McCroskey, D. F. Stephens, J. V. Whiteman and Robert Totusek. 1975. Yield and composition of Midland bermudagrass selected by beef cows and calves. J. Anim. Sci. 41:1728.

Templeton, W. C., Jr., and T. H. Taylor. 1975. Performance of bigflower vetch seeded into bermudagrass and tall fescue swards. Agron. J. 67:709.

Tilley, J. M. A., and R. A. Terry. 1973. A two-stage technique for in vitro digestion of forage crops. J. Brit. Grassl. Soc. 18:104.

Totusek, R., J. Gordon, F. P. Horn, W. E. McMurphy and L. Knori. 1974. How much nitrogen can we afford for bermudagrass? O.S.U. Agr. Exp. Sta. Res. p. 706.

Utley, P. R., W. H. Marchant and W. C. McCormick. 1977. Dixie crimson and Amclo arrowleaf clovers as pastures for growing steers. Georgia Agr. Res. 18:4.

Utley, P. R., D. Chapman, W. G. Monson, W. H. Marchant and W. C. McCormick. 1974. Coastcross-1 bermudagrass, Coastal bermudagrass and Pensacola bahiagrass as summer pasture for steers. J. Anim. Sci. 38:490.

Wilkinson, S. R., L. F. Welch, G. A. Hillsman and W. A. Jackson. 1968. Compatibility of tall fescue and Coastal bermudagrass as affected by nitrogen fertilization and height of clip. Agron. J. 60:359.

VITA

Terry L. Zachary, son of Kit and Oleta H. Zachary, was born December 13, 1953, at Detroit, Michigan. He was reared at Lebanon, Tennessee, and there attended elementary and secondary schools. He entered the University of Tennessee, Knoxville, in September 1973 and graduated with a B.S. degree in Agriculture. He began graduate studies in Animal Science at the University of Tennessee, Knoxville, in September 1976 and received the M.S. degree in August 1979.

He married the former Rebecca Jane Todd on August 28, 1976.