THE EFFECTS OF VARYING LEVELS OF NITROGEN FERTILIZATION UPON YIELD AND COMPOSITION OF MIDLAND BERMUDAGRASS AND ITS SUBSEQUENT PASTURING VALUE TO COWS AND CALVES

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

There has been a continual trend for many years in the livestock industry to utilize our natural resources to their greatest potential. One such resource being utilized is our land. The competition of man and domestic animals for cereal grains has been influential in the more extensive use of our marginal range lands. The development and incorporation of proper management practices to thousands of acres across the southern states covered by shrubs, trees and marginally productive ranges has lead to an increased interest in forage productivity.

Since the introduction of bermudagrass into Oklahoma, many acres have been planted with varying results. Although a large portion of this acreage is being utilized in stocker operations, the majority has been placed into more suited cow-calf programs, because of the general nature of the forage itself.

Numerous studies have been conducted involving the composition, availability and yield of bermudagrass using steers. These studies have involved varying levels of nitrogen application on numerous soil types. Most of these studies cover many generalities, with the detailed work involving grazing steers. Many times the results obtained from these studies are not applicable to the utilization of the forage by cows and calves. The main reason is that cows and calves can use a lower quality forage than would a growing stocker animal to perform properly.

The use of cows and calves to evaluate the forage would more nearly represent what we might expect. This is especially true when we attempt to make cross inferences from results obtained using growing steers as the principal animal to evaluate the forage.

It is very difficult to predict performance for a forage like bermudagrass and it is equally difficult to preduct the way grazing animals will respond to the forage. The difficulty of prediction is created by many factors. These factors include such aspects as soil types and fertility, geographical area, rainfall, grazing pressure, stage of maturity, and level of fertility which have pronounced effects upon yield and quality of bermudagrass. Because of these varying factors, it is difficult to predict forage yield and quality in one area under a given set of conditions from data obtained from another area under different conditions.

There are many measures for evaluating a forage, but for a true appraisal of the forage each must be considered within limits of evaluation. A common measuring unit of pasture forage production is weight yield per acre, and often times quality is thought of as being synonymous with protein content of the forage. While protein is a good measure of quality, the most reliable measure of forage quality is animal response to the forage consumed. Animal performance is influenced by rate of forage intake. Forage quality relates with nutritive value, and nutritive value is influenced by chemical composition and digestibility. For all practical purposes, rate of forage intake is directly related to nutritive value of a pasture when only one forage species is available.

The amount and quality of forage availability has a direct bearing on the amount of forage consumed and consequently, upon animal performance. It therefore appears possible that forage consumption and animal performance can be predicted if we have good measures of forage quantity and quality. In order to develop prediction equations, it is necessary that detailed laboratory characteristics of forage consumed and animal responses to wide ranges in forage quality be measured. Therefore, it is the primary purpose of this study to interrelate forage quantity and quality to animal performance and to develop regression equations from a wide range in quality of bermudagrass for use in predicting forage intake and animal response.

CHAPTER II

REVIEW OF LITERATURE

Factors Influencing The Voluntary Intake of Forages

Adequate forage consumption is essential for meeting satisfactory animal performance standards and is, therefore, one of the primary considerations in evaluating forages. However, it is misleading to evaluate a forage on the basis of just one criteria. Numerous attempts have been made to estimate forage quality on the basis of chemical composition, in vitro digestibility, rate of intake, and in vivo digestibility (Mott, 1959). The physiological mechanisms involved in voluntary feed consumption have not been clearly defined.

Several theories concerning voluntary intake have been proposed. Armstrong and Beever (1969) and Purser and Moir (1966) suggested that when ruminants are fed all-roughage diets, voluntary intake is limited by capacity of the gastrointestinal tract. Blaxter et al. (1961, 1962, 1966) considered the limiting mechanism to be total tract fill to $W^{.75}$ while Conrad et al. (1964) considered it to be fecal organic matter output per unit of body weight. Van Soest (1965) suggested the relationship of intake to plant cell wall content since cell solubles require little volume when in solution. Further results showed a greater change in intake per unit change in digestibility for grasses than for legumes which contain less cell walls. Weston (1967) concluded that fiber mass or volume, rather than digestibility, was the primary factor influencing forage intake.

Troelsen and Beacon (1970) working with steers consuming legume hays and hay silages observed that percent in vitro organic matter digestibility of the herbage was highly correlated with live weight gains, dry matter intake, dry matter digestibility and digestible energy. In studies of the seasonal variation in composition of Midland bermudagrass, McCroskey et al. (1968) found that crude protein and cell contents were positively related to dry matter digestibility and that ADF and lignin were negatively related to dry matter digestion. Studies on stage of maturity (Sheehan, 1969) indicated that there was a decrease in leaf percent, nitrogen content, in vitro digestibility, but an increase in crude fiber content of forages with advanced maturity. A positive correlation between voluntary intake and in vitro digestibility and a negative relationship between intake and crude fiber were also indicated. Gill et al. (1969), in studies with cows consuming high dry-matter silages (lucerne, timothy and brome grass), found correlation coefficients of 0.99 between relative rate of disappearance of digestible cellulose in vitro and intake of digestible dry matter of cows. Similar results were found by Allison and Osbourn (1970).

A relationship between cellulose and voluntary intake by the animal was reported by Crampton (1957) in which the rate of digestion is inhibited by anything that represses microflora activity. The author suggested that if cellulose digestion is retarded, the substrate remains in the rumen longer, but the sooner the ingesta moves out of the rumen the sooner hunger recurs and more food is eaten. Hungate (1966) reported the most complete digestion of forages would be obtained with the longest retention time in the rumen, suggesting a negative relationship between total digestion and intake. Work by Van Soest (1965) indicated that the lignin content was not as highly correlated with intake as it was with digestibility.

Recent attention has focused upon developing management practices for predicting animal performance because of the many discrepancies reported in many laboratory analysis results. Wilkinson et al. (1970) working with vertical layers of Coastal bermudagrass found that although "quality" as indicated by chemical composition and in vitro digestibility was greater in the upper layers, more total nutrients were present in the lower levels of the forage as a result of a greater dry matter yield. In studies of herbage by grazing cows Bryant et al. (1970) and grazing sheep Allden and Whittaker (1970) found a relationship between rate of intake and plant height. When herbage accessibility imposed limitations on feeding rates, sheep were unable to completely compensate reduced forage availability with an increase in grazing time. Results indicated that the animal consumed a larger portion of the whole plant and therefore more of the mature forage present. If there had been a grazing pressure that allowed an opportunity for more selective grazing, greater output per animal would have been obtained.

Fertility levels have been found to have an effect upon palatability, voluntary intake and animal performance (Corbett et al., 1963). Improvement in animal gain per acre, as a result of increases in the level of nitrogen, can be attributed to greater forage yield, allowing greater selection, and increased stocking rate (Elder and Murphy, 1961; Melton et al., 1964; Spooner and Ray, 1966). Generally nitrogen fertilization is associated with increased protein content of forage

(Alexander et al., 1961; Burton et al., 1963; Spooner and Ray, 1966) whereas percent of soluble carbohydrate tends to decrease (Webster et al., 1965; Hojjate, 1966; Wilkinson et al., 1970), there is little research to indicate that fertilization has a marked effect on the digestible energy content of forages (Riewe and Lippke, 1969).

Use of Chromic Oxide in Pasture Studies

It has long been of some importance to the researcher to determine the feeding value and voluntary intake of various rations and forages. A good estimate of the quantity of forage consumed would help explain animal performance in relation to laboratory quality determinations. The conventional method of placing animals in digestion stalls to measure intake is not applicable to grazing type situations. Nearly all methods used to estimate the quantity of intake by grazing animals are based on the principle of estimation of fecal output and subsequent division by estimation of indigestibility of the forage. Digestibility has been effectively estimated by *in vitro* digestion techniques (Tilley and Terry, 1963) and *in vivo* nylon bag technique (Van Keuren and Heinemann, 1962)

At the present time, chromic oxide is one of the indicators most widely used for the determination of total fecal output (Brisson et al., 1957; Clanton et al., 1962; Davis et al., 1958; Kane et al., 1953; Olubajo and Oupugo, 1971). Chromic oxide was first used as an external indicator by Edin (1918). Since that time it has been used as an indicator of digestibility, as an indicator of feed intake and as a rumen marker. Kane et al. (1952) stated that chromic oxide as an external indicator has certain advantages: (1) elimination of the need for total fecal collections; (2) the ability to conduct digestion and intake trials in the field; (3) substantial savings in time and expense; and (4) animals are under more natural conditions. Clanton et al. (1962), Davis et al. (1958), Hardison et al. (1954), and Putnam (1962) found the incorporation of chromic oxide into rations to be valid by comparing estimated total fecal output to that determined by total collection.

The general procedure of administering chromic oxide is to incorporate the indicator into the diet for a given period of time (six to ten days), and then to take morning and/or evening fecal-grab samples for a "sampling" period of five to seven days (Brisson et al., 1957; Hardison and Reid, 1953; Kane et al., 1952; Kiesling et al., 1969; Putnam, 1962; Smith and Reid, 1955). Frequency of administration influences the rate and variability of the recovery of chromic oxide from the feces. This variation in excretion rate is the main weakness of the indicator technique (Brisson et al., 1957; Clanton et al., 1962; Corbett et al., 1958; Davis et al., 1958; Hardison and Reid, 1953; and Kane et al., 1952). It has been suggested (Clanton, 1962; Davis et al., 1958) that a diurnal variation pattern should be established for each grazing trial and that "grab" samples should be taken at the same time each day in order to allow adjustments for diurnal variation.

Chemical Composition and Variability of Forage Samples Collected Using Fistulated Animals and Hand Sampling Techniques

Collecting samples of forage representative of the grazing animals diet is a complex problem since animals often select certain plants and/or plant parts. The selectivity of the animal may vary with species of animal, available plants, stage of plant maturity, grazing pressure, and weather conditions (Hancock, 1950; Heady, 1964; Springfield and Reynolds, 1951). The fact that animals do graze selectively indicates that hand sampling pasture forage is inaccurate in representing the diet of grazing animals (Torell, 1954; Lesperance et al., 1960a). The esophageal fistulation method for forage collection has been suggested as a method for demonstrating the degree of selective grazing and has also been useful in estimation of quality of forage consumed (Van Dyne, 1965).

Selectivity in diets by grazing animals has long been a factor puzzling researchers. Many of the first workers studying selectivity (Davies, 1925; Jones, 1933; Stapledon, 1934) suggested that the degree of selectivity was perhaps determined by the amount of palatable forage available where palatability is that quality in a forage plant that makes it preferred when a choice of available forage is present. Tiemann and Muller (1949) found no significant correlation between palatability and nutritive value (voluntary intake + digestibility) of forage in several classes of livestock. Later work by Hardison (1954) suggested that animals may have a preference for plant parts possessing certain physical qualities affecting palatability which may in turn affect the consumption of a diet differing chemically from the whole herbage. Other factors such as botanical composition, fertility of the soil, quantity of manure, and presence of burned or dried forage were suggested as factors which affect selectivity by the animal (Stapledon, 1934).

In many of the first grazing studies, various techniques were used to attempt duplication of the diet of the grazing animal. Data reported by Cook et al. (1951) suggested that hand-plucking plant material was acceptable for forage in pure stands, but was unacceptable for sampling of complex mixtures. Halls (1954), studying the estimation of quality of the diet through herbage sampling, found that precise evaluation could be made only when special emphasis was placed on the selection of plant portions actually being grazed. The search for better sampling techniques led to increased use of the esophageal fistula. Working with both esophageal and rumen fistulated cattle, Lesperance et al. (1960a) found esophageal fistula samples usually contained more nitrogen-free extract (NFE) and less fiber and phosphorus than rumen fistula samples. The esophageal fistula technique has the advantage of being adaptable to both cattle and sheep; sampling procedures using animals with well established esophageal fistulas are simpler and less time consuming than the rumen fistula technique.

Cook et al. (1958) first reported a new technique of range forage quality evaluation through the use of the esophageal fistulated animals. Results by Campbell et al. (1968) revealed organic matter recovery rates of 84 to 94 percent for concentrate rations while Kiesling et al. (1969) reported 90.4 percent recovery of grass samples. It has been reported that animal selectivity markedly affects chemical composition of forage ingested as compared to the herbage available. This is apparent from results of several studies in which chemical composition of clipped samples of available forage has varied considerably from that of samples recovered from rumen or esophageal fistulas (Bredon et al., 1967; Cable and Shumway, 1966; Campbell et al., 1968; Galt et al., 1969; Guthrie et al., 1968; Jefferies and Rice, 1969; Kiesling et al., 1969; Ridley et al., 1963; Theurer, 1969; Weir and Torell, 1959). Forage samples collected by esophageal or rumen fistulated animals were higher in ash and usually contained more crude protein than clipped or plucked samples (Bredon et al., 1967; Cable and Sumway, 1966; Campbell et al., 1968; Coleman and Barth, 1973; Galt et al., 1969, Guthrie et al., 1968; Kiesling et al., 1969; Olubajo and Oyenuga, 1970; Weir and Torell, 1959). Samples collected by esophageal fistulae are also usually lower in fiber than is clipped forage (Bredon et al., 1967; Guthrie et al., 1968; Weir and Torell, 1959).

Although the esophageal technique tends to provide samples more representative of forage consumed by intact animals, certain physical and chemical changes have been demonstrated in the samples collected. Early studies with fistulated animals (Barth et al., 1956; Barth et al., 1970; Lesperance et al., 1960a) indicated that salivary contamination significantly modified the composition of fistula samples by increasing ash content. This is in agreement with other results (Campbell et al., 1968; Hoehne et al., 1967; Kiesling et al., 1969; Marshall et al., 1967). Reports by Hoehne et al. (1967), Lesperance et al. (1960a), and Van Dyne and Torell (1964) indicated that phosphorus was the principal ash component increased by salivary contamination. These results indicated that the composition of fistula forage should be expressed on an ash-free basis.

Certain differences have also been found in the organic constituents of fistula-forage samples fed in pen-feeding trials; however, the differences and effects of these changes have not been consistent. Significant changes in protein, fiber and NFE have been reported in forage samples recovered from esophageal fistulae as compared to forage available for consumption (Blackstone et al., 1965; Compbell et al., 1968;

Hoehne et al., 1967; Kiesling et al., 1969; Lesperance et al., 1960a; Marshall et al., 1967). Crude fiber content of esophageal samples was higher than corresponding forage fed in studies by Lesperance et al. (1960a) and Marshall et al. (1967) while no differences were observed in studies by Barth et al. (1956), Campbell et al. (1968) and Hoehne et al. (1967). The inconsistency in these results may be due to incomplete recovery of all forage fed, sample preparation procedure and leaching of soluble components. Hoehne et al. (1967) compared chemical composition of "nonsqueezed" esophageal forage samples with samples which have been squeezed in an attempt to remove salivary contamination. Acid-detergent fiber (ADF) content of squeezed samples was greater in some grasses than in nonsqueezed samples. Squeezed esophageal samples had a lower mineral content than nonsqueezed samples. Results further indicated similar content of lignin, water soluble carbohydrates, and protein from both types of samples.

Marshall et al. (1967) studied the content of saliva and found crude fiber content negligible but saliva composition was 80 percent ash on a dry matter basis. This was suggested as the reason for higher ash content of esophageal fistula samples. Lesperance and Bohman (1964) reported that the addition of water or artificial saliva to hay samples followed by drying increased crude fiber, ADF, and ADL, and decreased NFE when compared to the original hay samples. It was also indicated that drying temperature had a significant influence on lignin and carbohydrate composition of grass and alfalfa hay samples. Van Soest (1965) showed that drying forages at temperatures above 50°C results in increased detergent fiber and lignin. Further results indicated that values were increased with the presence of moisture, increased temperature and time of drying. The increased yields of ADF and acid-detergent lignin could be accounted for largely by the production of artifact lignin via the nonenzymatic browning reaction. Studies by Torell et al. (1967) indicated that depravement for salt in the fistulated cattle and the subsequent consuming of salt-saturated soil appeared to be the cause of a significantly higher silica and ash level when esophageal samples were compared to available forage samples.

Forages selected by cattle and sheep have been shown to vary considerably between years, months, and days as well as within days (Bohman and Lesperance, 1969; Lesperance et al., 1960b; Van Dyne and Heady, 1965a). Van Dyne and Heady (1965a) reported that cattle and sheep diets had more crude protein and gross energy but less silica and total ash in early summer than in late summer. This is in agreement with the maturity effect found by Bohman and Lesperance (1967) and Lesperance et al. (1960b). Further results by Van Dyne and Heady (1965a) indicated that neither lignin, silica, nor cellulose changed significantly within a daily sampling period. Afternoon cattle diets were higher in crude protein than morning diets. Using the esophageal fistula technique, Torell et al. (1967) found no differences between animals for crude protein, crude fiber, and ether extract. There were significant differences between days for crude protein and ether extract but not for crude fiber. Guthrie et al. (1968), working with Coastal bermudagrass, found forage collected the first day of the week significantly higher in crude protein and lower in lignin than collected the fourth and seventh days. These results indicate a certain amount of variability due to time of sampling.

The effects of heavy and light grazing on blue grama as studied by Varva et al. (1973) indicated no great differences between pastures for crude protein, gross energy, acid-detergent fiber, lignin and cellulose in the diets. Heavy grazing also resulted in somewhat lower values for dry matter digestibility and intake. Similar results were obtained by Hardison et al. (1954). The reduction in intake and digestibility could be explained by the reduction of available forage and consequently of selection.

Effect of Fertilization and Maturity on Yield, Composition and Nutritive Value of Forages

Good management practices have been shown to influence the success of any forage program. This is especially true in grazing programs where animals are confined to small pastures to maximize production per unit area.

Fertilization of pastures has become a common practice in the United States, especially where adequate moisture is available. There are many responses obtained from N-fertilization, but increased forage yield is the most marked. Brown et al. (1943) studied the yields of several grasses fertilized with nitrogen and found a 30-percent increase in total forage yield. Ramage et al. (1958) working with orchardgrass and reed canarygrass, at varied levels of N (56.1, 112.2, 224.1, and 448.2 Kg N per hectare) found that forage yield ran from 3218.7 Kg with 56.1 Kg of nitrogen to 4572.2 Kg with 448.2 Kg of nitrogen. Burton et al. (1963), using a wide range of N-application (672.6 and 1681.2 Kg of 0-10-20 per hectare on Coastal bermudagrass), also noted linear increases in forage DM yield even at the highest level of N. Brown et al.

(1943) showed that the most uniform seasonal distribution of pasture herbage was obtained by adding nitrogen only in the summer, but that forage returns per unit of nitrigen were only half those of spring fertilizer treatment. Adams et al. (1967) showed that more uniform and greater total forage production could be obtained with four equal applications of N, P and K.

It was further demonstrated by Blaser (1964) that nitrogen fertilization of grasses increased carrying capacity and livestock production per acre; output per animal, however, was not generally affected. Higher yield of animal produce, weight gains, per acre from an intensive utilization program was attributed to higher forage yields (Blaser et al., 1959; Elder and Murphy, 1961; Melton et al., 1964; Spooner and Ray, 1966). Similar results were obtained by Spooner et al. (1966), although it was apparent from his study that of the stocking rates (.8094, .6070, .4042 and .2023 hectares per steer) one steer per .4047 hectares had a detrimental effect on forage quality. This effect was thought to be attributed to manure droppings and excessive trampling under the heavier stocking rate, which in turn limited the intake of available forage. In some studies steer gains have increased with increasing level of nitrogen (Spooner and Clary, 1960; Hogg and Collins, 1965; Spooner and Ray, 1966), while in others no beneficial effects on daily gain were observed (Elder and Murphy, 1961; Melton et al., 1964).

Nitrogen application and maturity alter the chemical composition of forage which is related to nutritive value and animal performance (Raleigh, 1970). Crude protein content of forages has been the most readily changed by N-application. In general, as level of nitrogen fertilizer is increased, crude protein content of the forage is increased (Alexander et al., 1961; Burton et al., 1955; Burton et al., 1963; Burton et al., 1968; Fisher and Caldwell, 1959; Hoveland et al., 1960; Knox et al., 1957; McCullough and Burton, 1962; Patterson et al., 1963; Prine et al., 1956; Ramage et al., 1958; Reid et al., 1965; Reid et al., 1966; Reid et al., 1967; Smith et al., 1963; Woodle et al., 1955). Soluble carbohydrates tend to decrease with increasing levels of N fertilization (Webster et al., 1965; Hojjati, 1966; Wilkinson et al., 1970). Blaser et al. (1964) indicated that both crude protein content and its apparent digestibility were increased by N-application. Riewe and Lippke (1969) reported that except for the increases in crude protein and decreases in soluble carbohydrates, there seems to be variable results on the other constituents as affected by fertilization.

In studies by Webster et al. (1965) high N-application (1569 Kg per hectare) had no apparent affect on in vitro digestibility. Seasonal changes were noted in all tests; in vitro digestibility was highest in the spring and dropped considerably by mid-summer. Changes in other constituents, due to nitrogen application, included a significant decrease in crude fiber, ash and NFE contents (Ramage et al., 1958). Working with bermuda forage at high levels of N-application Webster et al. (1965) showed decreases in holocellulose of about 13 percent and in hemicellulose of over 20 percent. Further results indicated lignin percentages to be highest when digestibility was lowest. The lowered digestibility and consequent lignin percentages were offered as reasons for failure of cattle to do well on bermudagrass in the summer (Knox et al., 1957; Webster et al., 1965).

Nutritive value and acceptability have also been shown to be influenced by N-application and maturity. Burton et al. (1968) working with clipped bermudagrass at varied levels of N-application (0, 56, 112, 224, 336, 448, 672, 1009, 1345 and 1681 Kg per hectare) indicated that percentage consumption to total forage offered increased as the nitrogen rate increased from zero to several hundred kilograms (673-1009) of N per hectare. These findings were similar to those by Reid et al. (1967) working with fescue hay. Reid indicated that estimated intake values of sheep consuming herbage fertilized with higher levels of nitrogen were greater than non-fertilized grasses. These results were also consistent with those found by Reid, Jung, and Kinsey (1967) using orchardgrass. Further studies indicated that in general, there is a decline in intake with increasing maturity (Alexander et al., 1961; Reid et al., 1964; Reid et al., 1967). Working with varying levels of N-application (0, 56, 112, 224, 336, 448, 673, 1009, 1345, and 1681 Kg per hectare) Burton et al. (1968) found no evidence of reduced palatability at these levels, while Reid et al. (1967) found that N fertilization improved the relative acceptance of herbage as measured in palatability experiments with grazing sheep. Smith et al. (1963), studying Coastal bermudagrass, also reported that palatability was improved by nitrogen fertilization and clipping. Similar results on palatability estimates of various forages have been obtained by Alexander et al. (1961), Burton et al. (1955), Hoveland (1960), McCullough and Burton (1962), Patterson et al. (1963), and Reid et al. (1966).

Another factor influenced by fertilization was reported by Spooner and Clary (1962). Their results indicated a residual nitrogen carry over in the soil after applying fertilizer at rates of 0, 56, 112, and 224 Kg of nitrogen per hectare annually over a three-year period. It was noted that TDN increased significantly from year to year, especially at the 224 Kg treatment level. The TDN values during the three-year period were 2451, 3283, and 3395 Kg per hectare, respectively.

CHAPTER III

YIELD AND COMPOSITION OF MIDLAND BERMUDAGRASS FERTILIZED AT THREE LEVELS

Summary

Three forage sampling techniques were used to study the effect of N fertilization on yield and composition of Midland bermudagrass (Cynodon dactylon). Fifty-three hectares of bermudagrass were divided into 12 pastures and each pasture was fertilized in three split applications (May, July and September) with one of three levels of N (67, 207 and 336 Kg N/ha) and one application (May) of P_2O_5 and K_2O on the basis of soil analysis. Monthly forage production was determined under wire exclosures (CC). Esophageal fistulated cows (12) and calves (12) were used to sample the composition of bermudagrass being selected (EC). Hand clipped samples (HC) were used for estimation of yield and quality of available forage. Increasing levels of N fertilizer increased DM yield ($P < .05$). Chemical analysis of CC samples indicated an increase in crude protein (CP) and neutral detergent fiber (NDF) with increasing levels of N fertilizer when adequate moisture was available. Effects of level of N were not consistent, however, in dry seasons. Results of analysis of HC samples from the two trials indicated decreasing value for *in vitro* dry matter disappearance (IVDMD), CP, gross energy (GE), and residual ash while increases in acid detergent fiber (ADF), lignin (ADL) and cellulose were noted from trial 1 to trial 2. Animals tended

to select forage that contained more CP and residual ash, and less GE and cellulose in trial 1 (May) and more digestible forage with higher levels of CP, ADL, and less cellulose in trial 2 (July). Composition of monthly forage production under cages tended to be more similar in quality to that selected EC for IVDMD and CP than that by HC samples.

Introduction

It has been established that yield of bermudagrass linearly increases up to at least 900 Kg of N (Burton et al., 1963; Burton et al., 1969; Lovelace et al., 1968). Results from various studies (Alexander et al., 1961; Burton et al., 1963; Spooner and Ray, 1966) have indicated that except for increased crude protein, with reductions in percent of soluble carbohydrates (Hoggarti, 1966; Webster et al., 1965; Wilkinson et al., 1970), N application has little influence on the energy yielding constituents of forage. However, research information has been published on the influence of N application on various other chemical constituents of forage (Blaser et al., 1964; Fisher and Caldwell, 1959; Knox et al., 1957, 1958; Ramage et al., 1958; Riewe and Lippke, 1969; Webster et al., 1965).

Composition of forages has been compared by various methods including hand clipping, hand plucking, cage clipping, and esophageal sampling (Bredon et al., 1967; Cable and Shumway, 1966; Campbell et al., 1968; Coleman and Barth, 1973; Galt et al., 1967; Guthrie et al., 1968; Kiesling et al., 1967; Obioha et al., 1970; Weir and Torell, 1959). This study was conducted to observe the influence of varied levels of N fertilization on yield and chemical composition of grazed forage measured by cage clipping, hand clipping and esophageal sampling.

Materials and Methods

Experimental Pastures. Fifty-three hectares of Midland bermudagrass (Cynodon dactylon) were divided into 12 pastures and each pasture was fertilized in split applications (May, July and September) with one of three levels of N (67, 207 and 336 Kg N/ha). Phosphorus (P_2O_5) and potassium (K_2O) were applied, in accordance with soil test results, in a single application in May. Pasture size decreased with increasing level of nitrogen fertilizer application. These pastures were grazed by mature cows and their calves with five pairs allotted to each pasture. A group of extra cows and calves was used as "put-and-take" animals to control grazing pressure and maintain a similar amount of forage per unit area in each pasture. Pastures were dragged when necessary to prevent excessive manure buildup. The pastures were located in the rolling plains of Central Oklahoma at the Fort Reno Research Station near El Reno. Average rainfall in this area is about 76.2 to 81.3 cm. but in this particular year, rainfall from June to October was low at 22.76 cm. This factor influenced total forage yield and quality differences.

Esophageal Fistulated Animals. There were twelve cow-calf pairs used in the experiment; each was equipped with an esophageal fistula using surgical techniques and post-operative care as described by Thedford (1972). The closure device was a variation of "3C" described by Van Dyne and Torell (1964). The variation in the closure device was created by using an off-centered polyethylene plate and rotating it every seven to ten days to reduce the pocketing difficulty in the esophagus with frequent losses of fistulas. When the animals were not in use for collections, the fistulas were replaced and the animals were allowed to graze the bermudagrass available in extra holding pastures.

Collection of Forage Samples. There were three types of forage samples collected for chemical analysis and forage production determination during the spring and summer of 1972. Five circular wire cages, 1.22 m. high and 1.22 m. in diameter, were randomly located in each of the 12 pastures. Forage samples were collected under these cages using a .61 m. x .61 m. quadrad on the first day of each month of the growing season (May to October). Samples were clipped 2.54 cm. above ground and dried at 55°C in forced air ovens for 48 hours. Samples were weighed for DM yield and then ground through a 1 mm. wiley mill and composited (5 from each pasture) on an equal DM basis for chemical analysis. Grazed samples, representative of the animals' diets, were collected by the use of esophageal fistulated cows and calves during May and July of 1972. These samples were collected during a six-day period, with one cow and calf pair per pasture per day. Animals were rotated to a different pasture during each of the six collection days so that each animal was allowed to sample each pasture treatment. Cows and calves were penned up at night with access to water but not feed to eliminate any problems associated with regurgitation. Sample collection of animals was begun at 9:30 a.m. each morning by removal of closure device and placement of canvas collection bag. These collection bags were made in such a manner that holes in the bottom would allow adequate drainage. When bags were intact, animals were turned out into their respective pastures for approximately a 30-minute grazing period. Cows and calves were allowed to graze separately to eliminate any contamination of forage sample by calves nursing their mothers. After the allotted grazing period, animals were returned to the holding facilities where bags with samples were removed and closure devices were re-inserted. When esophageal sampling was completed, animals were returned to their respective grazing pastures until they were brought up for drylot prior to darkness. Collected forage samples were placed in cloth sampling bags, dried in a forced air oven at 55°C for 48 hours and then stored in plastic bags for chemical analysis. Hand-clipped samples (HC), representative of forage available for consumption, were collected at the same time as esophageal samples. These "available forage" samples were clipped at random from a .76 m. by 9.14 m. strip 1.22 cm. high, from which pasture DM and available DM forage were determined. Five representative areas of forage were used to collect samples per pasture. Subsamples were taken from these collections and dried at 55°C in a forced air oven. These samples were ground through a 1 mm. wiley mill and stored in plastic bags. All samples from the same pasture were composited on an equal DM weight for later individual pasture laboratory analysis.

Laboratory Procedures. All forage samples were analyzed for dry matter, crude protein by the A.O.A.C. (1965) methods and acid-detergent fiber (ADF), neutral-detergent fiber (NDF), hemicellulose (ADF-NDF), residual ash, and permanganate lignin by the Van Soest (1963) method. *In vitro* dry matter disappearance was determined by the Tilley and Terry (1963) method. Rumen liquor for incubation was collected from a steer being fed a partial ration of bermudagrass. Gross energy values were determined using an energy bomb galvenometer. Cellulose was determined by procedures described by Crampton and Maynard (1938).

Statistical Analyses. All statistical analyses were made using a computer program prepared by Barr and Goodnight (1971). The analysis of variance suboption was used to test for differences in response due to N treatments on pastures. Differences between individual pastures were tested by the use of the least significance difference test (Steel and Torrie, 1960).

Results and Discussion

Monthly Forage Production. Monthly forage DM production values, as determined using the CC sampling-quadrad technique, are shown in Table I for each N fertilizer treatment. Forage production increased with increasing levels of N fertilizer ($P < .05$) as expected on the basis of earlier reports (Burton et al., 1963; Spooner and Ray, 1966). It is important to note, however, that N fertilization had little effect upon DM yield in June through September. This may be attributed to subnormal summer rainfall (Table II).

Chemical composition, GE and IVDMD values for CC samples collected monthly during the 1972 grazing season are presented in Table III. Crude protein, GE and digestibility data suggested that forage quality decreased as the season advanced. This may have in part been due to dry conditions whereas lignin levels in the forage also decreased as the season advanced. Quality of fertilized bermudagrass (IVDMD and CP) decreases as the season progresses.

N fertilization had no effect ($P > .05$) on any chemical component except CP. CP increased ($P < .05$) with increasing levels of N fertilizer, as previously reported by McCroskey et al. (1968).

Available Forage vs. Esophageal Samples. Average available-forage DM values for the three N fertilizer treatments are presented in Table IV. Although DM forage available for consumption are not different ($P < .05$), total forage availability per pasture does show contrasting

TABLE I

ESTIMATES OF FORAGE D.M. PRODUCTION FROM CAGE CLIP SAMPLING IN 1972 TRIALS

Treatment	Kg DM/hectare/month[1]						Total	Average/ Month
	May	June	July	Aug.	Sept.	Oct.		
1. 67 (kg/ha)	1596	1908	1564	1112	410	126	6716	1119
2. 202 (kg/ha)	1933	862	1675	993	424	153	7040	1173
3. 336 (kg/ha)	2792	2188	1874	1048	440	152	8494	1416

[1]Monthly mean values of 5 cage samples from each pasture and 4 replicates for each treatment gives 20 observations for each treatment value.

TABLE II

RAINFALL FOR FT. RENO AREA DURING 1972 TRIAL

	Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Rainfall 1972	.13	.22	.34	3.75	5.48	1.76	1.08	1.69	.74	3.69	3.30	.95	23.13
Annual average	1.15	1.31	1.62	2.85	4.79	3.83	2.40	2.51	2.71	2.85	1.65	1.33	29.08
Difference	-1.02	-1.09	-1.28	.90	.69	-2.07	-1.40	- .82	-1.97	.84	1.65	- .38	- 5.95
Rainfall 1972 (cm)	.05	.09	.13	1.48	2.16	.69	.43	.67	.29	1.45	1.30	.43	10.49
Annual average (cm)	.45	.52	.64	1.12	1.89	1.51	.95	.99	1.07	1.12	.65	.60	13.19
Difference (cm)	- .40	- .43	- .51	.36	.27	- .81	.52	.32	.78	.33	.65	.17	2.70

TABLE III

CHEMICAL CONSTITUENTS OF MONTHLY CAGE CLIPPING FORAGE SAMPLES DURING THE 1972 TRIAL

Constituents	Level of N Application[f]	May[g] $\bar{X}$	May SE[h]	June $\bar{X}$	June SE	July $\bar{X}$	July SE	August $\bar{X}$	August SE	September $\bar{X}$	September SE
Crude protein, %	1	13.65^{c}		12.55		12.17^{c}		14.50^{c}		15.16	
	2	14.85^{d}	±.39	13.46	±.38	14.53^{d}	±.44	15.90^{d}	±.29	16.82	±.46
	3	15.53^{d}		13.84		14.68^{de}		15.46		15.80	
Acid-detergent fiber, %	1	35.51		36.49^{c}		32.17		33.32		30.15	
	2	34.50	±.39	36.14	±.27	31.90	±.25	32.93	±.38	29.14	±.40
	3	35.15		35.18^{d}		32.07		32.79		29.58	
Neutral-detergent fiber, %	1	72.93		75.38		75.00		71.03		70.46	
	2	73.08	±.68	77.68	±.63	74.28	±.74	70.73	±.57	68.37	±.89
	3	74.09		76.78		73.11		72.70		70.49	
Residual ash, %	1	3.23		2.05^{c}		3.21		2.70		3.48	
	2	3.16	±.21	2.82^{d}	±.14	2.81	±.13	2.38	±.15	2.30	±.28
	3	2.99		2.54		3.15		2.43		2.10	
Lignin, %	1	6.48		5.42		4.17		4.82^{a}		4.63	
	2	6.86	±.17	5.18	±.13	5.03	±..19	5.29^{bc}	±.07	4.64	±.12
	3	6.56		5.24		4.47		4.92^{d}		4.35	
Cellulose, %	1	33.44		32.88		29.99		24.14		23.34	
	2	32.44	±.33	31.74	±.34	29.85	±.17	23.73	±.24	22.13	±.29
	3	32.08		31.85		29.43		23.98		23.30	
Gross Energy, Kcal/g	1	5.83^{a}		5.80		5.53		5.33		5.35^{c}	
	2	5.83	±.09	5.78	±.02	5.42	±.12	5.72	±.11	5.98^{d}	±.12
	3	5.35^{b}		5.85		5.55		5.58		5.81	
IVDMD, %	1	55.95		48.23		48.85		48.26		53.24^{c}	
	2	55.80	±1.27	48.03	±.47	50.33^{a}	±.52	50.09	±.61	55.21^{d}	±.37
	3	52.13		48.49		47.08^{b}		50.43		53.20^{ce}	

[ab] Values with different superscripts were different (P<.05).

[cde] Values with different superscripts were different (P<.05).

[f] Level of N fertilization (1=67, 2=202, 3=336 kg/ha).

[g] Twenty observation for each mean; representative of 4 pastures with 5 cage samples from each pasture.

[h] Standard error of the mean.

TABLE IV

FORAGE AVAILABILITY FOR CONSUMPTION DURING TRIALS IN 1972

Treatment	Available DM kg/hectare		Available DM (kg)/cow-calf pair	
	May	July	May	July
1. 67 kg/ha	1098.6	1120.4	1125.0	1147.3
2. 202 kg/ha	1190.1	1128.4	920.0	872.3
3. 336 kg/ha	1206.2	1554.2	648.9	836.2

differences in trials 1 and 2. More forage was available with increasing levels of N, but yield responses were not as great as expected. Chemical composition, GE and IVDMD values for EC and HC samples collected during trials 1 and 2 are presented in Table V. Mean crude protein content of the forage was higher ($P < .05$) for treatment three than treatment one in the May collection for calves, but no other treatments were different ($P < .05$). Failure of N fertilization to bring about changes in some components may be attributed to subnormal levels of available moisture. Results of the analysis of HC samples indicated an increasing level of crude protein with increasing levels of N fertilization, in both trials. The level of CP in HC samples decreased ($P < .01$) from May to July. As the season advanced, IVDMD, residual ash and GE decreased, while ADF, lignin, NDF and cellulose increased in HC samples. Similar changes have been reported by McCroskey et al. (1968) and Ramage et al. (1958).

In trial 1, cows selected diets containing more ash ($P < .05$), lignin and ADF ($P < .01$) but less GE ($P < .01$), NDF and cellulose ($P < .05$). Calves selected diets higher in residual ash, ADF and CP ($P < .05$) but lower in GE, ADF and NDF ($P < .01$). In trial 2 cows selected diets containing more residual ash ($P < .05$), NDF, lignin, GE, CP and IVDMD ($P < .01$), but less cellulose ($P < .05$). Reports by Barth and Kazzal (1971), Bredon et al. (1970), and Kiesling et al. (1969) all reported higher CP levels in selected forage as well as increased ash levels. Guthrie and Rollings (1968) reported lower ADF values in "selected samples" than in HC samples, while Barth and Kazzal (1971) and Kiesling et al. (1969) found more ADF in esophageal samples than in HC samples. Kiesling et al. (1969) also reported more lignin in selected samples, while

TABLE V

CHEMICAL CONSTITUENTS OF ESOPHAGEAL AND HAND CLIPPED SAMPLES FROM GRAZED PASTURES

Item	Level of N Application	May (Trial 1) Cows[f]		Calves[f]		H.C.[g]		July (Trial 2) Cows		Calves		H.C.	
		$\bar{X}$	SE[h]	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE
Crude protein, %	1	20.19		20.34^{a}		18.61^{a}		16.44		17.65		10.63^{c}	
	2	19.70	±.75	21.68	±.63	19.93	±.54	16.42	±.28	18.52	±.22	11.53	±.35
	3	22.18		24.47^{b}		22.40^{b}		16.52		17.72		12.36^{d}	
Acid-detergent fiber, %	1	41.98		40.74		33.86^{c}		40.55		38.18		41.50	
	2	42.80	±1.04	38.66	±1.21	33.62	±.54	40.28	±.34	37.60	±.69	40.62	±.44
	3	41.25		37.18		32.34^{d}		39.54		39.29		38.94	
Neutral-detergent fiber, %	1	62.44		62.38		74.71		79.89		79.98		79.03	
	2	64.76	±1.72	63.29	±1.39	72.81	±.80	80.84	±.84	79.98	±1.10	79.60	±.29
	3	64.87		62.66		74.34		79.11		78.65		78.51	
Residual ash, %	1	6.09		5.27		4.15		5.01		4.76		3.25	
	2	5.50	±.21	6.15	±.36	3.48	±.22	5.01	±.20	5.44	±.30	2.58	±.26
	3	5.17		5.40		3.48		5.09		4.74		3.28	
Lignin, %	1	6.12		5.39		5.75		6.73		7.18		6.58^{c}	
	2	5.77	±.21	5.17	±.29	5.62	±.21	6.98	±.18	6.37	±.13	6.11	±.10
	3	6.04		5.40		6.03		6.57		6.85		5.97^{d}	
Cellulose, %	1	35.85		35.38		28.78^{a}		33.82		31.00		33.54^{a}	
	2	37.02	±.33	33.50	±.55	28.32^{c}	±.38	33.30	±.55	31.23	±1.36	32.41	±.35
	3	35.20		31.78		26.39^{bd}		32.98		32.44		30.95^{b}	
Gross Energy, Kcal/g	1	4.28		4.26		5.47		4.75		5.01		4.70	
	2	4.43	±.09	4.47	±.11	5.64	±.06	4.72	±.09	4.63	±.10	4.60	±.05
	3	4.44		4.40		5.68		4.62		4.44		4.53	
IVDMD, %	1	52.88		52.62		53.58		52.47		52.79		37.95^{c}	
	2	55.16	±1.12	52.09	±1.49	53.74	±1.02	52.69	±.61	51.57	±1.08	38.81	±.63
	3	53.80		50.29		52.72		49.47		50.86		40.85^{d}	

[ab]Means in the same column with different superscripts were different ($P<.05$).

[cde]Means in the same column with different superscripts were different ($P<.1$).

[f]Random samples collected by esophageal animals; mean values represent an average of 24 samples for each treatment.

[g]Random samples collected from grazed pasture areas by hand clipping method.

[h]Standard error of the mean.

Edlefsen et al. (1960) reported lower lignin values. Barth and Kazzal (1971) reported higher IVDMD values in selected samples of forage in one trial and lower values in another while Coleman and Barth (1973) showed adjusted IVDMD to be greater for selected forage.

It was concluded that the available forage was quite uniform in the early spring during trial 1. In trial 2, however, quantity of forage was limited because of inadequate rainfall. All comparisons of ash between HC and EC differed significantly ($P < .05$) across treatments. These results were to be expected due to salivary contamination (Barth, Weir, Torell, 1956; Blackstone, Rice and Johnson, 1965; Hoehne et al., 1967; Kiesling, 1969; and Barth, 1971). It should also be pointed out that some fistulated animals appeared to consume soil around closed mineral boxes during collection periods. Torell, Bredon and Marshall (1967) suggested that depraved appetites for salt in esophageal-fistulated cattle and the subsequent consuming of salt-saturated soil appeared to be the cause of higher silica and ash values in forage. This contamination could also account for lower energy and higher fiber values in certain samples.

Animals were apparently uniformly selective in their grazing because the forage selected was similar even though fertilizer treatments altered composition of available forage. Grazing selectivity was even more apparent in July when variability in forage quality was greater. Results indicated that even though animals were selective for higher levels in July as the level of N increased, the margin between HC and esophageal samples decreased, indicating a tendency for animals to select the highest quality of forage present regardless of treatment.

CHAPTER IV

THE RELATIONSHIP OF ANIMAL PERFORMANCE AND DRY MATTER INTAKE TO CHEMICAL CONSTITUENTS OF GRAZED FORAGE

Summary

Midland bermudagrass was fertilized with three levels of N (67, 207 and 332 kg/ha) to determine the effects of N fertilization level upon quality and quantity of forage and its relationship to forage intake and cattle performance. Monthly forage samples were collected under cages (CC) and information on both forage yield and chemical composition was collected. Sixty Angus x Hereford cows were mated to Angus bulls and randomly allocated to 12 pastures on the basis of calving date. Both forage dry matter intake and animal performance were determined. Esophageal fistulated cows (12) and calves (12) were used to sample the quality of forage being selected (EC). Hand clipped (HC) samples were collected during the same periods of CC sampling to serve as a comparison of available forage. Chemical analyses were made on all three types of samples. Increasing levels of N fertilization had no significant ($P > .05$) effect on quantity of forage consumed by cows or calves. Mean values were 121.3 and 97.7 $g/W_{kg}^{.75}$ for cows in May and July, respectively, and 42.3 $g/W_{kg}^{.75}$ for calves in July. Forage intake was positively correlated to *in vitro* digestibility and negatively correlated to lignin.

Forage intake was regressed on composition of forage (IVDMD, CP, ADF, NDF, hemicellulose (NDF-ADF), permanganate lignin, residual ash, and cellulose) determined from esophageal samples. Correlations of forage intake with single composition values were quite variable since there were apparent interactions. Coefficients of determination (r^2) ranged from 0.0003 (for CP in May for cows) to 0.407 (for cellulose in May for cows). Combinations of variables gave higher (r^2) values in both trials. These values ranged from 0.107 for DE and hemicellulose for calves in July to .869 for hemicellulose + cellulose + ADF + lignin for calves in July. These results indicate that a single equation for predicting intake from variables is inadequate. Therefore, independent equations need to be used when predicting intake for cattle types during different months or collection periods.

Increasing levels of N improved the quality of forage selected by calves ($P < .05$) for CP but otherwise had no effect. However, calves tended to select forage with higher levels of CP and lower levels of ADF and cellulose than did cows in both trials.

Average daily gain from birth to weaning for the three treatments (.788, .809 and .787 Kg) and adjusted 205 day weights (191.4, 194.8 and 191.1 Kg) were not significantly affected ($P > .05$) by increasing level of N.

Introduction

The effects of level of N fertilization and maturity of forages on yield, digestibility, stocking rate and steer gains have been reported (Burton et al., 1969; Elder and Murphy, 1961; Melton et al., 1964; Reid et al., 1959; Spooner and Ray, 1966); a wide range of soil types, climates and management systems were involved. Although intake, digestibility and performance of sheep and steers on bermudagrass have been determined (Hawkings et al., 1964; Hogg and Collins, 1965; Melton et al., 1964; Spooner and Clary, 1960; Elder and Murphy, 1961; Suman et al., 1962), results are not necessarily applicable to cows and calves, because a lower quality forage can be used by cows and calves. Since animals tend to graze selectively (Arnold, 1960; Bredon et al., 1967; Conner et al., 1963; Galt et al., 1969; Hardison et al., 1954; Heady and Torell, 1959; Van Dyne and Heady, 1965ab; Weir and Torell, 1959) and consume forages at different times during the day and night (Kropp et al., 1973), results from pen fed studies with selected and clipped hay cannot be effectively applied to grazing animals. Some detailed laboratory analyses on the composition of forages have been reported, but relatively little information relating quality of forage to voluntary intake and gain of grazing animals is available. The objective of this study was to relate forage quality and quantity to forage intake and performance of grazing cows and calves.

Materials and Methods

Pastures. Twelve Midland bermudagrass (Cynodon dactylon) pastures were used in a randomized block design with three levels of N application (67, 207 and 332 Kg N/ha). Monthly forage samples (May to October) were collected under cages (CC) to determine the amount of new growth each month of the growing season. Hand clipped samples (HC) were collected in grazed areas during both forage intake trials for chemical analysis of forage available for consumption. Pastures were dragged when necessary to prevent excessive manure buildup.

Animals. Sixty Angus x Hereford cows were mated to Angus bulls and randomly allocated to the 12 pastures on the basis of calving date. The animals were allowed to graze their respective pastures ad-libitum from the beginning of the experiment in the spring. Put-and-take animals from the same cattle pool were used to maintain a similar amount of available forage in all pastures. Only cows were used to determine intake in trial 1 (mid May); calves were not used because of their small size. Calves were large enough by mid July (trial 2) so that both cows and calves could be used.

Esophageal fistulated cows (12) and calves (12) were used to collect forage samples for laboratory analysis; individual animal samples were composited within pastures to give a representative sample of grazed forage for laboratory analyses (Telford et al., 1973). All animals were provided shade, water and minerals except when animals were used in esophageal collection periods. At this time, waterers and mineral boxes were covered to eliminate contamination of selected forage.

Animal Performance Records. Cow and calf weights (Table VI) were obtained after an overnight stand without feed but with access to water, except that calves were shrunk 12 hours without feed and water prior to weaning.

Forage intake by the 60 pairs of cows and calves was determined by the Cr_2O_3 technique. The Cr_2O_3 (15 g/cow, 10 g/calf) was administered in 45 and 35 cc gelatin capsules beginning at 6:30 a.m.; cattle were randomly gathered by pasture groups. The Cr_2O_3 was administered for six days prior to collection of fecal samples during days 7 through 12; rectal "grab" samples were collected in new plastic 5.51 x 3.15 cm bags from each cow at the time of Cr_2O_3 administration. Samples were frozen

TABLE VI

PERFORMANCE OF COWS AND CALVES GRAZING MIDLAND BERMUDAGRASS FERTILIZED AT THREE DIFFERENT LEVELS

Item	Nitrogen level kg/ha: 67	202	332
	Total wt. gain kg.	Total wt. gain kg.	Total wt. gain kg.
Cow weight change			
From 4-21 to 6-17 (59 days)	66.5	65.8	71.3
From 6-19 to 7-24 (35 days)	12.2	8.2	11.8
From 7-24 to 10-9 (77 days)	-2.8	-2.7	-10.7
From 4-21 to 10-9 (171 days)	76.1	71.2	72.4
Calf weight change			
From 4-21 to 7-24 (94 days)	83.7	90.1	90.9
From 7-24 to 10-9 (77 days)	54.3	57.2	50.8
From 4-21 to 10-9 (171 days)	138.0	147.3	141.7
Average daily gain to (7-24)[a]	.83	.82	.85
Average daily gain to (10-9)[a]	.79	.81	.79
205 day weaning weight[a]	191.38	194.84	191.14
Available forage, kg/ha			
Trial 1 (May)	1098.6	1190.1	1206.2
Trial 2 (July)	1120.4	1128.4	1554.2
Hectares/cow-calf pair	1.02	.77	.54

[a]Calves weights adjusted for sex.

for storage and later dried in forced air draft ovens at 60°C. Dried samples were composited on an equal dry weight basis for each animal to remove any day-to-day variation in fecal output. A diurnal variation curve was established from two cow-calf pairs from each pasture. Pairs were placed into one of three pastures according to their respective N fertilization level for a 48-hour period after the six-day fecal collection period. Chromium concentrations, analyzed by an atomic absorbtion spectrometer, were converted to unadjusted fecal output by the following formula:

$$\text{Unadjusted fecal output (gm DM/day)} = \frac{Cr_2O_3 \text{ concentration (gm/day)}}{Cr_2O_3 \text{ in feces (gm/gm DM)}}$$

A diurnal variation curve was plotted. The deviation from the mean in percentage of unadjusted fecal output at the time the sample was collected was used as a correction factor to derive the adjusted fecal output. Diurnal curves for each of the three treatments were formed from samples collected at four-hour intervals beginning at 6:30 a.m. during 48 hours. The curve mean was divided by the mean of the 6:30 a.m. values to establish a correction factor:

$$\text{Correction factor} = \frac{\text{Mean output values of 48-hour curve}}{\text{Mean of four 6:30 a.m. output values of curve}}$$

This correction factor was used to adjust all 6:30 a.m. values. Fecal output was converted to intake with the following equation:

$$\text{Intake (gm/day)} = \frac{\text{Adjusted output (gm DM/day)}}{100\text{-\% \textit{in vitro} digestibility}} \times 100$$

In vitro dry matter disappearance was determined by the method of Tilley and Terry (1963).

Chemical Analysis. Esophageal forage samples were analyzed as described by Telford et al. (1973). Digestible energy was computed by subtracting total gross energy of fecal output from total gross energy of forage intake (esophageal samples were used as representative samples of the diet consumed).

Statistical Analysis. The basic design was a randomized block with three treatments and four blocks with experimental unit being pasture. The reason for blocking was to eliminate as much variation attributed to soil type as possible. All statistical analyses were made using a computer program prepared by Barr and Goodnight (1971). The analysis of variance suboption was used to test for differences in response due to N application. Differences between treatments were tested by the use of the Least Significance Difference (Steel and Torrie, 1960). In addition, the regression correlation suboption was used to regress intake upon chemical composition.

Results and Discussion

Composition, DE and Intake. Chemical composition of the selected forage for both trials is presented in Table VI. Intake and digestibility energy (DE) for treatments and trials are presented in Tables VII and VIII. Performance data for animals are presented in Tables IX, X, and XI. The dry matter content of pastures for the three treatments and two trials (May and July) were 37.3%, 38.9% and 35.7% and 56.4%, 55.8% and 59.4%, respectively. It should be noted that marginal amounts of rainfall beginning in mid June greatly influenced forage production and further results in this study.

Increasing levels of N fertilization had no significant ($P > .05$) effect on quantity of forage consumed by cows or calves. Overall means were 121.3 and 97.7 $g/W_{kg}^{.75}$ for cows in May and July, respectively, and

TABLE VII

DRY MATTER INTAKE AND DIGESTIBLE ENERGY OF COWS AND CALVES GRAZING BERMUDAGRASS AT THREE LEVELS OF N DURING TRIALS IN MAY AND JUNE

Nitrogen Level	May		July			
	Cows		Cows		Calves	
	Daily Intake					
KgN/ha	g/100 lb BW	$g/W_{kg}^{.75}$	g/100 lb BW	$g/W_{kg}^{.75}$	g/100 lb BW	$g/W_{kg}^{.75}$
67	121.58	117.33	101.78	101.29	53.16	40.54
202	129.45	123.77±5.68[a]	97.59	96.15±4.58	58.82	44.81±2.47
332	122.64	122.88	98.02	95.62	54.03	41.82
	Digestible energy, Kcal/g					
67	2.311		2.572		5.000	
202	2.589		2.414		4.857	
332	2.529		2.203		4.030	

[a]Standard error of the mean.

TABLE VIII

COMPARISON OF ESOPHAGEAL SELECTED AND AVAILABLE FORAGE RELATIVE TO CHEMICAL CONSTITUENTS, GROSS ENERGY, AND *IN VITRO* DRY MATTER DISAPPEARANCE OF MIDLAND BERMUDAGRASS FOR THREE LEVELS OF N FERTILIZATION IN MAY

Item	Forage type	Cows: Nitrogen level, kg/ha 67	202	332	Calves: Nitrogen level, kg/ha 67	202	332
Crude protein, %	Selected[a]	20.19	19.70	22.18	20.34	21.68	24.47
	Available[b]	18.61	19.93	22.40	18.61	19.93	22.40
	Difference[c]	-1.58	-.23	-.22	1.73	1.75	2.07*
Acid-detergent fiber, %	Selected	41.86	42.80	41.25	40.74	38.66	37.18
	Available	33.86	33.62	32.34	33.86	33.62	32.34
	Difference	8.12***	9.18***	8.91***	6.88***	5.04***	4.84***
Neutral-detergent fiber, %	Selected	62.44	64.76	64.87	62.38	63.29	62.66
	Available	74.71	72.81	74.34	74.71	72.81	74.34
	Difference	-12.27***	-8.05***	-9.47***	-12.33***	-9.52***	-11.68***
Residual ash, %	Selected	6.09	5.50	5.17	5.27	6.15	5.40
	Available	4.15	3.48	3.48	4.15	3.48	3.48
	Difference	1.94***	2.02***	1.69**	1.12	2.67***	1.92***
Lignin, %	Selected	6.12	5.77	6.04	5.39	5.17	5.40
	Available	5.75	5.62	6.03	5.75	5.62	6.03
	Difference	.37	.15	.01	.64	-.45	-.63
Cellulose, %	Selected	35.85	37.02	35.20	35.38	33.50	31.78
	Available	28.78	28.32	26.39	28.78	28.32	26.39
	Difference	7.70***	8.70***	8.90***	6.60***	5.18***	5.39**
Gross Energy, kcal/g	Selected	4.28	4.43	4.44	4.26	4.47	4.40
	Available	5.47	5.64	5.68	5.47	5.64	5.68
	Difference	-1.19***	-1.21***	-1.24***	-1.21***	-1.17***	-1.28***
IVDMD, %	Selected	52.88	55.16	53.80	52.62	52.09	50.29
	Available	53.58	53.74	52.72	53.58	53.74	52.72
	Difference	-.70	1.42	1.80	-.96	-1.65	-2.43*

[a]Represents average forage selected by the grazing animals.

[b]Represents average forage available to the animals.

[c]Represents magnitude of selectivity.

* Significant (P<.1); ** Significant (P<.05); *** Significant (P<.01).

TABLE IX

COMPARISON OF ESOPHAGEAL SELECTED AND AVAILABLE FORAGE RELATIVE TO CHEMICAL CONSTITUENTS, GROSS ENERGY, AND *IN VITRO* DRY MATTER DISAPPEARANCE OF MIDLAND BERMUDAGRASS FOR THREE LEVELS OF N FERTILIZATION IN JULY

		Cows			Calves		
		Nitrogen level, kg/ha			Nitrogen level, kg/ha		
Item	Forage type	67	202	332	67	202	332
Crude protein, %	Selected[a]	16.44	16.42	16.52	17.65	18.52	17.72
	Available[b]	10.63	11.53	12.63	10.63	11.53	12.63
	Difference[c]	5.81**	4.89**	4.16**	7.02**	6.99**	5.36**
Acid-detergent fiber, %	Selected	40.55	40.28	39.54	38.18	37.60	39.27
	Available	41.50	40.62	38.94	41.50	40.62	38.94
	Difference	-.95	-.34	.60	-3.32***	-3.02***	.33
Neutral-detergent fiber, %	Selected	79.89	80.12	79.11	79.98	79.39	78.65
	Available	79.03	79.60	78.51	79.03	79.60	78.51
	Difference	.86	.52	.60	.95	-.21	.14
Residual ash, %	Selected	5.01	5.47	5.09	4.76	5.44	4.74
	Available	3.25	2.58	3.28	3.25	2.58	3.28
	Difference	1.76**	2.89**	1.86**	1.51	2.80**	1.51
Lignin, %	Selected	6.73	6.98	6.57	7.18	6.37	6.85
	Available	6.58	6.11	5.97	6.58	6.11	5.97
	Difference	.15	.87	.60	.60	.26	.88
Cellulose, %	Selected	33.82	33.30	32.98	31.00	31.23	32.44
	Available	33.53	32.41	30.95	33.54	32.41	30.95
	Difference	.28	.89	2.03*	2.54**	1.18*	1.49
Gross Energy, kcal/g	Selected	4.75	4.72	4.62	5.01	4.63	4.44
	Available	4.69	4.60	4.53	4.70	4.60	4.53
	Difference	.05	.12	.09	.31	.03	-.09
IVDMD, %	Selected	52.47	52.69	49.47	52.79	51.57	50.86
	Available	37.95	38.81	40.95	37.95	38.81	40.95
	Difference	14.52***	13.88***	8.52***	14.84***	12.76***	9.91***

[a]Represents average forage selected by the grazing animals.

[b]Represents average forage available to the animals.

[c]Represents magnitude of selectivity.

* Significant ($P < .1$); ** Significant ($P < .05$); *** Significant ($P < .01$).

TABLE X

COMPARISON OF COWS VS. CALVES FOR FORAGE CHEMICAL CONSTITUENTS, GROSS ENERGY, *IN VITRO* DRY MATTER DISAPPEARANCE, D.M. INTAKE, AND DIGESTIBLE ENERGY DURING TRIAL 1 (MAY)

Item	Nitrogen level, kg/ha					
	67		202		332	
	Cow	Calf	Cow	Calf	Cow	Calf
Composition Esophageal Forage						
Crude protein, %	20.19	20.34	19.70	21.68	22.18[a]	24.47[b]
Acid-detergent fiber, %	41.90	40.74	42.80[a]	38.66[b]	41.25	37.18
Neutral-detergent fiber, %	62.44	62.38	64.76	63.29	64.87	62.66
Residual ash, %	6.09	5.27	5.50	6.15	5.17	5.40
Lignin, %	6.12[c]	5.39[d]	5.77[c]	5.17[d]	6/04[c]	5.40[d]
Cellulose, %	35.85	35.38	37.02	33.50	35.20	31.78
IVDMD, %	52.88	52.62	55.16	52.09	53.80	50.29
GE, Kcal/g	4.28	4.26	4.43	4.47	4.44	4.40
Forage dry matter intake $g/W_{kg}^{.75}$	117.33		123.77		122.88	
Digestible energy, Kcal/g	2.31		2.59		2.53	

a b Means in same treatment were significant ($P < .10$).

c d Means in same treatment were significant ($P < .05$).

e f Means in same treatment were significant ($P < .01$).

TABLE XI

COMPARISON OF COWS VS. CALVES FOR FORAGE CHEMICAL CONSTITUENTS, GROSS ENERGY, IN VITRO DRY MATTER DISAPPEARANCE, D.M. INTAKE, AND DIGESTIBLE ENERGY DURING TRIAL 2 (JULY)

	Nitrogen level, kg/ha					
	67		202		332	
Item	Cow	Calf	Cow	Calf	Cow	Calf
Composition Esophageal Forage						
Crude protein, %	16.44[c]	17.65[d]	16.42[e]	18.52[f]	16.52[c]	17.72[d]
Acid-detergent fiber, %	40.55[a]	38.18[b]	40.28[a]	37.60[b]	39.54	39.72
Neutral-detergent fiber, %	79.89	79.98	80.12	79.39	79.11	78.65
Residual ash, %	5.01	4.76	5.47	5.44	5.09	4.74
Lignin, %	6.73	7.18	6.98	6.37	6.57	6.85
Cellulose, %	33.82[a]	31.00[b]	33.30	31.23	32.98	32.44
IVDMD, %	52.47	52.79	52.69	51.57	49.47	50.86
GE, Kcal/g	4.75	5.01	4.72	4.63	4.62	4.44
Forage dry matter intake, $g/W_{kg}^{.75}$	101.29	40.54	96.15	44.81	95.62	41.82
Digestible energy, Kcal/g	2.57	5.00	2.42	4.86	2.20	4.03

a b Means in same treatment were significant ($P < .10$).

c d Means in same treatment were significant ($P < .05$).

e f Means in same treatment were significant ($P < .01$).

42.3 g/$W_{kg}^{.75}$ for calves in July. There was a tendency for a decreased intake from May to July for cows.

Overall means for DE were 2330 and 2397 Kcal/g for cows in May and July and 4629 Kcal/g for calves in July. Results of digestible energy (DE) for cows in May indicated less DE for the lowest level of N while the other two levels had similar DE values. The opposite was true for the July trial since the highest DE values corresponded to the lowest level of N and the lowest DE for the highest level of N. The calves' trend for July was quite similar to that of the cows. The decrease and variability in intakes and DE could be attributed to several factors. Higher intakes were associated with higher <u>in vitro</u> dry matter digestibility values and lower intakes were associated with higher lignin content of forage selected. Maturity apparently affected composition of forages as evidenced by decreases in <u>in vitro</u> dry matter digestibility and CP and increases in lignin, cellulose, ADF and NDF from May to July. These factors have all been shown to influence intake. McCroskey et al. (1968) studied the effect of seasonal variation in bermudagrass and found CP and cell contents were positively related to dry matter digestion and that dry matter digestion was negatively correlated to ADF and lignin. Sheehan (1969) also reported that the maturity factors indicated a positive correlation between voluntary intake and <u>in vitro</u> digestibility and a negative correlation between intake and crude fiber, while Van Soest (1965) indicated that lignin content was not as highly correlated with intake as it was with digestibility.

<u>Regression Analysis</u>. Forage intake was regressed on the composition of forage (IVDMD, CP, GE, ADF, permanganate lignin, residual ash, NDF, cellulose and hemicellulose (NDF-ADF)) determined from esophageal

samples. Prediction equations from intake determination are presented in Tables XII, XIII, XIV, and XV. The coefficient of determination (r^2) for single components ranged from 0.0003 to 0.41 for CP and cellulose in May and 0.03 to 0.39 for GE and hemicellulose in July for cows. Calves (r^2) values in July ranged from 0.009 to 0.27 for residual ash and hemicellulose. These results indicate that perhaps more than one variable must be used in forming a reliable prediction equation for intake. Van Soest (1963) reported that chemical composition on the whole is much more closely related to digestibility than voluntary intake. The interrelationships between intake, digestibility and chemical composition are highly species-oriented. However, as the CWC fraction increases, voluntary intake declines with an increasing negative slope. The results suggest that the relationship between digestible dry matter and voluntary intake depends on the proportion of digestible energy from cell-wall contents. Coefficient of determination (r^2) values for cows ranged from 0.2803 for CP + hemicellulose to 0.4924 for IVDMD + ADF + NDF in May and 0.1066 for IVDMD + ADL to 0.7839 for DE + hemicellulose in July, while calves' (r^2) values ranged from 0.197 to 0.869 for IVDMD + cellulose and hemicellulose + cellulose + ADF + ADL. Decreases in IVDMD and increases in lignin corresponded with a decline in voluntary intake. These results agree with work by Troelson and Beacon (1970) and Sheehan (1969). These relationships probably occur by lignin lowering digestibility simply by its formation of an indigestible complex of lignin and cellulose, therefore reducing the digestibility of cellulose. It was apparent that the quality of the forage being consumed decreased to the extent that quality plus quantity of available forage significantly ($P < .05$) changed voluntary intake from May to July.

TABLE XII

SIMPLE CORRELATION COEFFICIENTS BETWEEN CHEMICAL CONSTITUENTS, *IN VITRO* DRY MATTER DIGESTIBILITY DIGESTIBLE ENERGY, AND FORAGE DRY MATTER INTAKE FOR COWS IN MAY AND COWS AND CALVES IN JULY

	FORAGE DRY MATTER INTAKE, $g/W_{kg}^{.75}$		
	May	July	
	Cows	Cows	Calves
Item	r	r	r
Crude protein	-.0176	.4773	-.4907
Acid-detergent fiber	-.1272	.5046	.1375
Neutral-detergent fiber	.5978	-.3480	.4590
Hemicellulose (NDF-ADF)	.5245	-.6247	.5158
Residual ash	.1415	-.5342	.0929
Lignin	-.5578	-.2679	-.4855
Cellulose	-.0177	.6659	.2927
In vitro dry matter digest.	.3980	.2256	.2502
Gross energy	.3357	-.1731	-.1300
Digestible energy	.5880	.5533	.4715

TABLE XIII

SIMPLE AND PARTIAL REGRESSION COEFFICIENTS BETWEEN DM INTAKE AND VARIOUS COMBINATIONS OF BERMUDA FORAGE CHEMICAL CONSTITUENTS SELECTED BY COWS IN MAY

Intercept	DE	IVDMD	CP	GE	ADF	ADL	Residual ash	NDF	Cellulose	Hemicellulose	(r^2)[1]	CV[2]	SE[3]
							Simple regression coefficients						
9.049	.0013										.3462	6.625	8.04
6.217		.110									.1587	7.515	9.12
12.276			-.007								.0003	8.192	9.94
8.214				.894							.1127	7.717	9.36
13.655					-.036						.0162	8.126	9.86
16.927						-.802					.3112	6.799	8.25
11.210							.165				.0200	8.110	9.83
5.279								.107			.3574	6.570	7.97
12.326									-.0054		.0003	8.190	9.94
10.326										.073	.2571	6.980	8.46
							Partial regression coefficients				(R^2)[1]		
7.848		.055								.059	.307	7.19	8.73
.618		.154							.089		.208	7.64	9.27
3.781			.074						.259		.440	6.47	7.84
11.098		-.028								.074	.280	7.33	8.89
9.220	.0009									.021	.3545	6.94	8.41
11.361	.0016	-.059									.3627	6.89	8.36
12.612		.029			-.4645					.034	.349	7.39	8.97
14.923		.021	.034		-.7699						.327	7.51	9.12
-5.042		.131		.0851			.1021				.492	6.53	7.92
9.690		.073			.0667	-.717					.3542	7.36	8.93
14.513		.034			-.703						.321	7.11	8.63
9.119						-.2956			.168	.017	.465	6.70	8.13
14.580						-.538				.035	.341	7.01	8.50
6.651					.0572	-.275			.1449	.042	.485	7.03	8.52

[1]Coefficient of determination.

[2]Coefficient of variation, %.

[3]Standard error of the estimate.

TABLE XIV

SIMPLE AND PARTIAL REGRESSION COEFFICIENTS BETWEEN DM INTAKE AND VARIOUS COMBINATIONS OF BERMUDA FORAGE CHEMICAL CONSTITUENTS SELECTED BY COWS IN JULY

Intercept	DE	IVDMD	CP	GE	ADF	ADL	Residual ash	NDF	Cellulose	Hemicellulose	(r^2)[1]	CV[2]	SE[3]
							Simple regression coefficients						
5.773	.0012										.3062	8.36	8.16
4.956		.0934									.0509	9.77	9.55
.679			.5523								.2279	8.81	8.61
12.113				-.4989							.0299	9.88	9.65
-6.449					.4042						.2546	8.66	8.46
12.535						-.4093					.0718	9.67	9.44
13.464							-.7121				.2854	8.48	8.28
20.840								.107			.1211	9.40	9.19
-8.603									.5506		.4435	7.48	7.31
20.050										-.2597	.3902	7.83	7.65
							Partial regression coefficients				(R^2)[1]		
17.404		.0446								-.2510	.4014	8.18	7.99
-12.478		.0802							.5428		.4809	7.62	7.44
7.584			.4148						-.1532		.2409	9.21	9.00
17.3890		.0707							-.3717		.2079	9.41	9.19
13.5770			.2824							-.2892	.4375	7.93	7.75
17.798	.0014										.7839	4.92	4.80
4.258	.0012	.0513								-.2476	.3209	8.71	8.51
20.180		.0314				-.3307					.4471	8.34	8.15
-1.581		.0519	.5236			-.0086					.2428	9.70	9.53
2.079		.0568			.5517			-.2179			.5687	7.37	9.20
-10.442		.0738			.5249	-.6886					.4917	7.99	7.81
8.210		.0782				-.3649					.1066	9.99	9.76
20.116						-.4623			.1367	-.2872	.4502	8.32	8.12
22.148						-.3472				-.2534	.4416	7.90	7.72
5.716					.4881	-.4854			-.2052	-.1524	.7151	6.40	6.25

[1]Coefficient of determination.

[2]Coefficient of variation, %.

[3]Standard error of the estimate.

TABLE XV

SIMPLE AND PARTIAL REGRESSION COEFFICIENTS BETWEEN DM INTAKE AND VARIOUS COMBINATIONS OF BERMUDA FORAGE CHEMICAL CONSTITUENTS SELECTED BY CALVES IN JULY

Intercept	DE	IVDMD	CP	GE	ADF	ADL	Residual ash	NDF	Cellulose	Hemicellulose	(r^2)[1]	CV[2]	SE[3]
							Simple regression coefficients						
3.319	.0002										.2223	9.59	4.07
2.374		.0360									.0626	10.53	4.46
8.856			-.257								.2408	9.48	4.02
4.9232				-.1457							.0169	10.79	4.57
3.070					.0305						.0189	10.77	4.57
6.735						-.367					.2357	9.51	4.03
4.022							.0436				.0086	10.83	4.59
-1.221								.0688			.2107	9.66	4.10
2.099									.0678		.0855	10.40	4.41
-.228										.1090	.2661	9.32	3.95
							Partial regression coefficients				(R^2)		
-.6815		.0139								.1926	.2744	9.77	4.14
.0856		.0376							.0699		.1537	10.55	4.47
5.632			-.1839						.0662		.2709	9.79	4.15
4.195			-.1912							.0849	.3862	8.98	8.98
.396	.0001									.0778	.3332	9.36	3.97
5.3369	.0003	-.0493									.2652	9.83	4.17
.9671		.0546				-.5117				.0958	.6574	7.12	3.02
8.763		.0673	-.2447			-.5305					.6868	6.81	2.89
-1.543		.0126			-.0777			.1022			.2866	10.27	4.35
1.515		.0786			.0724	-.6056					.5704	7.97	3.38
3.871		.0766				-.5287					.4729	8.33	3.53
-.387						-.5759			.1839	.0789	.8359	4.93	2.09
2.[illegible]						-.4033				.1187	.5486	7.70	3.27
-1.[illegible]51					.0432	-.6072			.1714	.0809	.8694	4.70	1.99

[1]Coefficient of determination.

[2]Coefficient of variation, %.

[3]Standard error of the estimate.

Selectivity Between Animals. Calves tended to be more selective for higher levels of CP and lower levels of ADF and cellulose than did cows (Tables X and XI). This difference may be partially attributed to calves' accessibility to nurse their dams while confined to drylot at night. Although the calves would have a reduced appetite, these differences could be attributed to other factors; further research in this area could answer these questions.

Performance of Cows and Calves. Performance data for cows and calves are found in Tables IX, X, and XI. Although not significant ($P > .05$), total cow weight changes from April 21 to October 9 showed the greatest gain (76.1 kg) for cows on the low level of N (67 kg/ha) while the other two levels of N gave about the same gain (71.2 and 72.4 kg for 202 and 336 kg/ha, respectively). The early weighing period from April 21 to June 19, the greatest weight gains were noted for cows on the highest level of N (336 kg/ha) with 71.3 kg, while the other two treatments had approximately the same gains (66.5 and 65.8 kg) for treatments 67 and 202 kg/ha. Weight changes from June 19 to July 24 indicated approximately the same gains in weight for the three treatments (12.2, 8.2 and 11.8 kg). The last weight change period was from July 24 to October 9 and in this period of time animals began to lose weight. The greatest weight loss was for the high level of N (332 kg/ha), with a loss of 10.8 kg; the other two treatments (67 and 202 kg/ha) had losses of 2.8 and 2.7 kg, respectively. Total calf weight gains adjusted for sex from April 21 to October 9 for the three treatment were 138.0, 147.3 and 141.7 kg. The weight gains from April 21 to July 24 were 83.7, 90.1 and 90.9 kg and from July 24 to October 9 weight gains were 54.3, 57.2 and 50.8 kg. The trends of weight changes indicated that the quality and quantity of forage influenced these variables. Average daily gains were computed for two periods during the growing season: birth to July 24 and July 24 to October 9. Daily gains were .83, .82 and .85 for the first period and .79, .81 and .79 kg for the second period, for the three treatments respectively. Adjusted 205-day weaning weights were 191.4, 194.8 and 191.1 kg for the three respective treatments. Performance of calf weight gain per hectare was 75.78, 102.0 and 143.4 kg for the respective treatments. These weights are representative of the different stocking rates.

Quality of Intake and Performance. Calves tended to select less digestible forage as level of N increased, while cows on the lowest level of N selected diets less digestible than those on the two highest levels. Troelsen and Beacon (1970), working with hays and hay silages, observed that *in vitro* organic matter digestion highly correlated with ewe weight gain and dry matter intake, dry matter digestibility and DE. Gross energy for cows and calves was less for each increasing level of N in July. In May gross energy tended to increase with increasing level of N for cows while calves' values were higher for the two highest levels of N. No definite trends within treatments were noted for lignin although increases were noted with increasing maturity. The lowest intakes in May for cows were associated with the lowest digestibility and highest lignin content, while highest intakes were associated with higher digestibility and lowest lignin content. Similar results have been reported by Sheehan (1969) and Van Soest (1965). Intakes of cows in May (Table X) indicated that the lower level of N application had the lowest intakes, while the higher levels of N had the highest intakes. Higher intakes were associated with forages higher *in vitro* dry matter digestibility (IVDMD) and gross energy (GE), while the lower intakes were associated with the lower IVDMD and GE values. The greater intakes by calves in July (Table XI) were associated with the medium level of N and the lowest intakes with the low level of N. Highest intakes by calves were associated with highest CP and lowest lignin and cellulose. IVDMD was inconsistent in this trial for calves. McCroskey et al. (1968), studying seasonal variation of bermudagrass, found similar results. Under a system of grazing which allows maximum selection, one expects to obtain a higher rate of performance per animal unit since the animal has an opportunity to select higher quality forage (Spooner and Ray, 1966). It was evident from visual observation that variation of forage quantity was not as great in May as it was in July. Marginal rainfall seriously reduced the amount of forage available for selection in the latter months of the growing season.

The available forage per cow-calf pair (Table IX) indicates that more forage was present for the lowest level of N because of larger pasture sizes. The higher intake values for cow in May were also associated with the lower level of N; this was perhaps indicative of more available forage DM from which to select.

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APPENDIXES

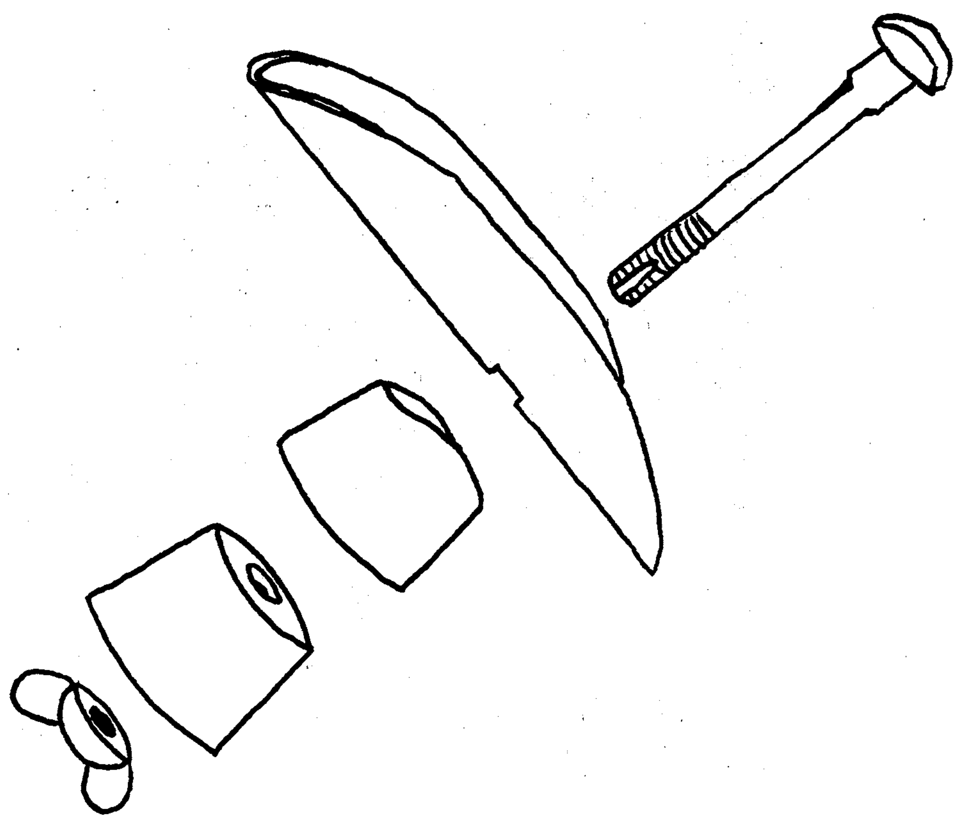

Figure 1. Cannula Disassembled Showing Various Parts.

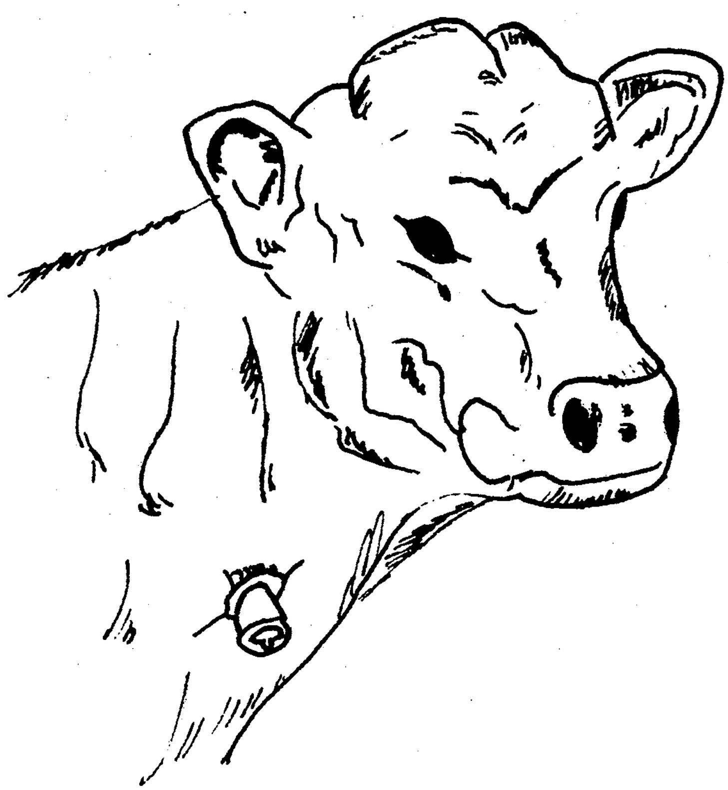

Figure 2. Location of Cannula in Animal's Neck.

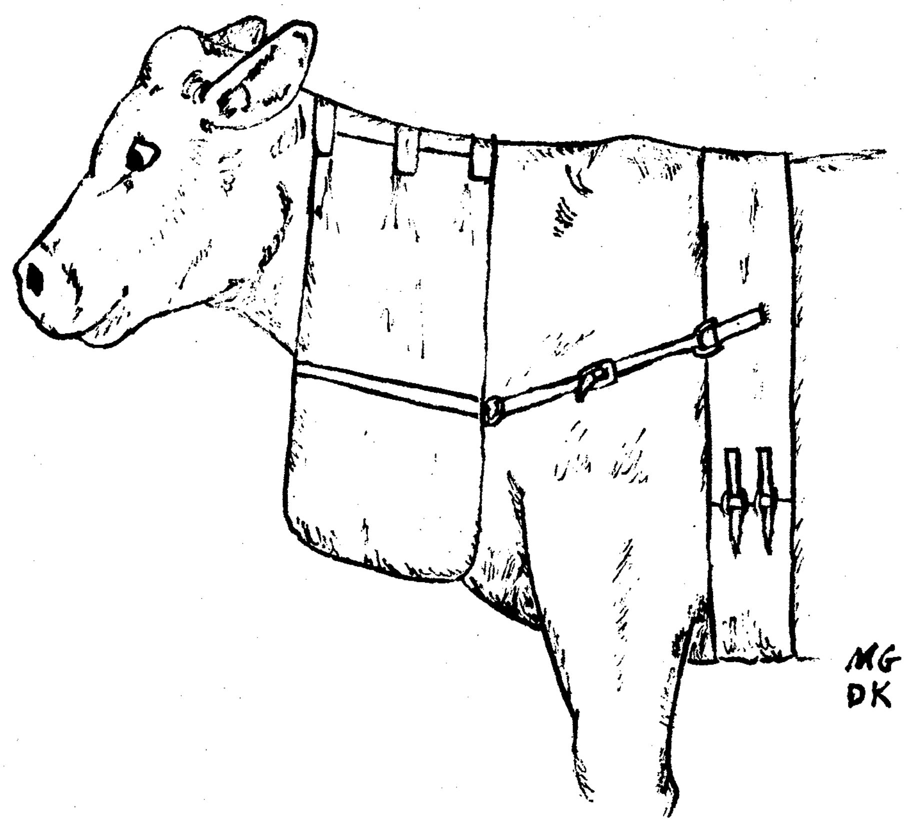

Figure 3. Cow Equipped with Collection Bag.

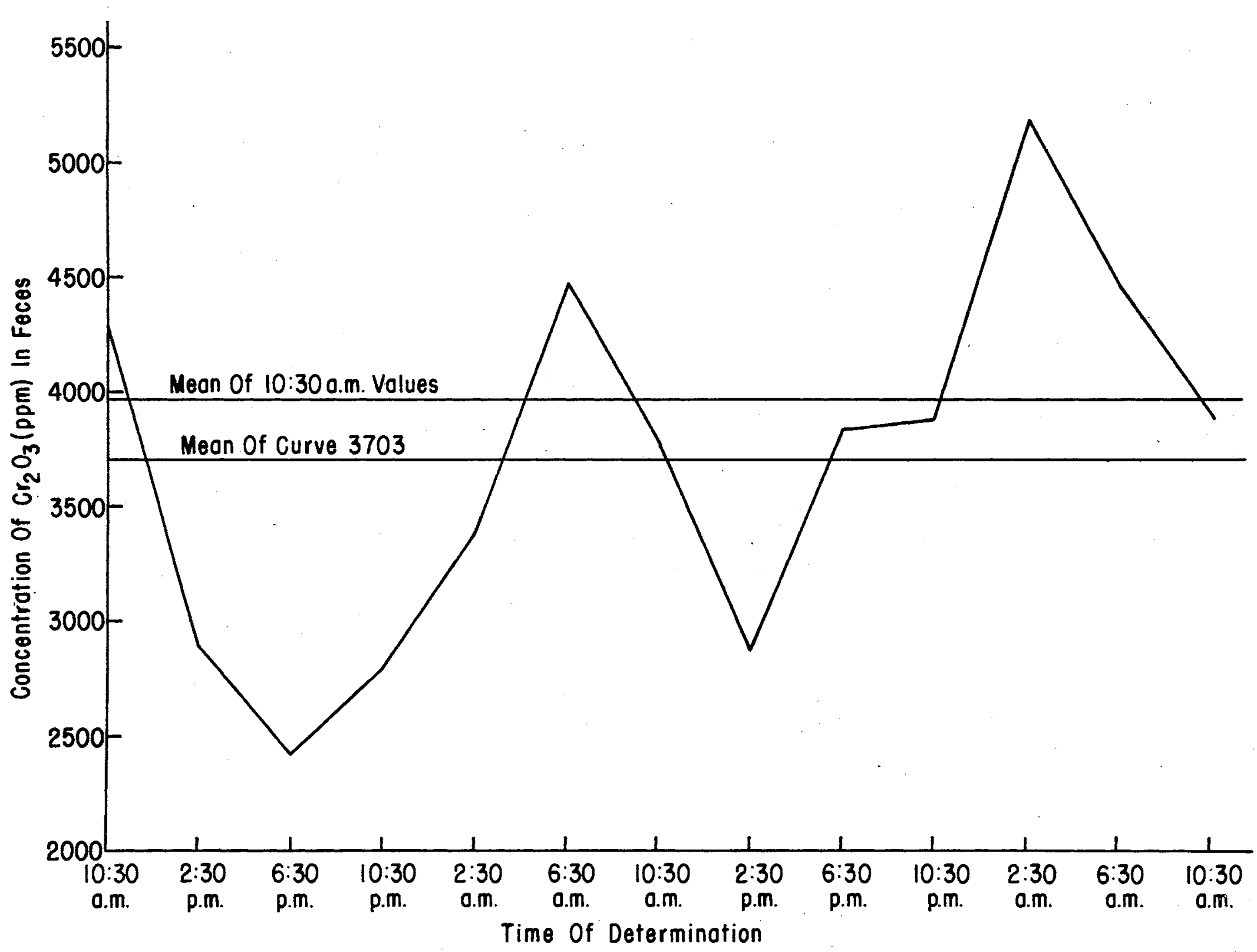

Figure 4. Diurnal Excretion Curve of Chromic Oxide for Cows in July on Low Level of N.

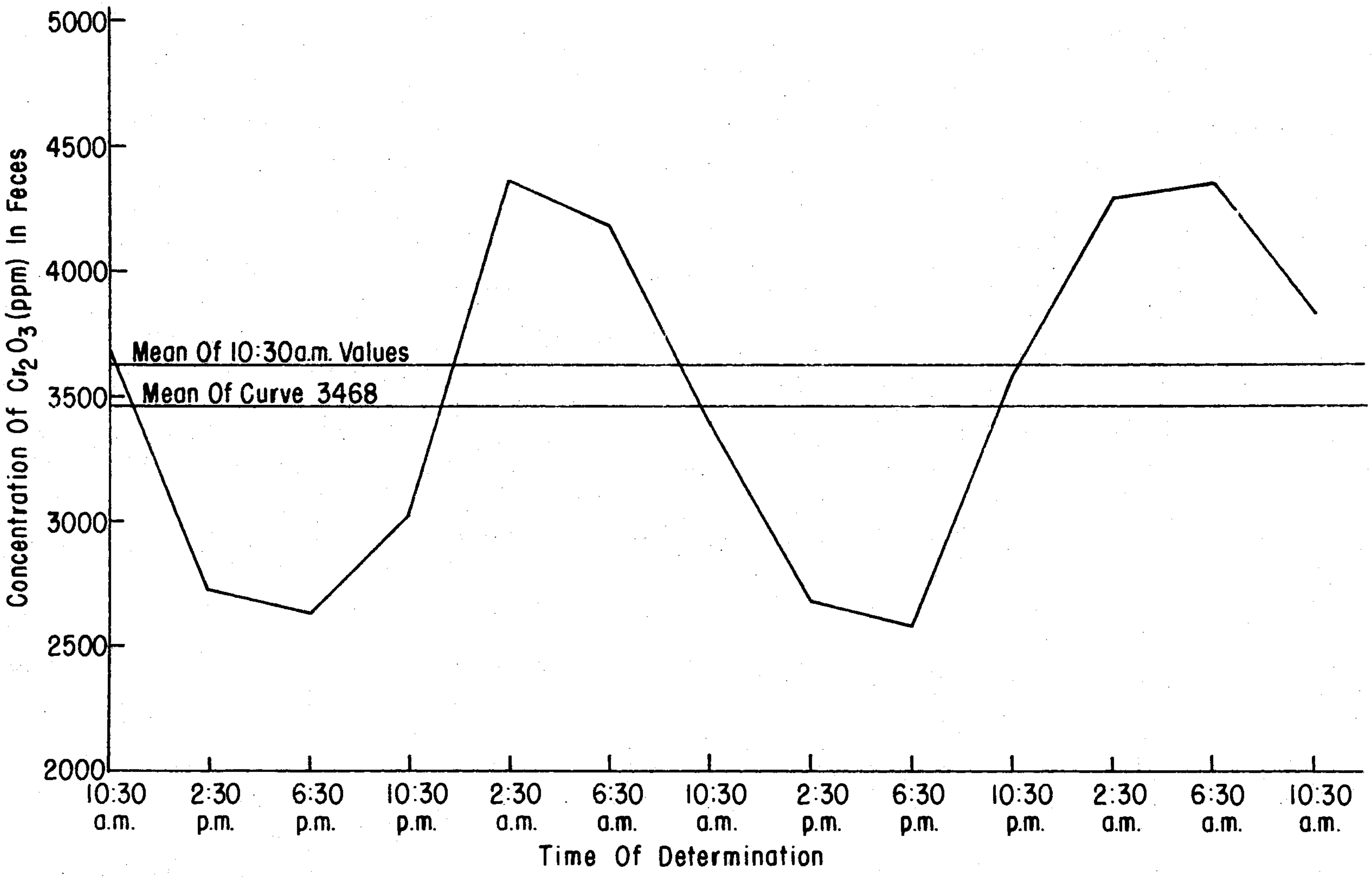

Figure 5. Diurnal Excretion Curve of Chromic Oxide for Cows in July on Medium Level of N.

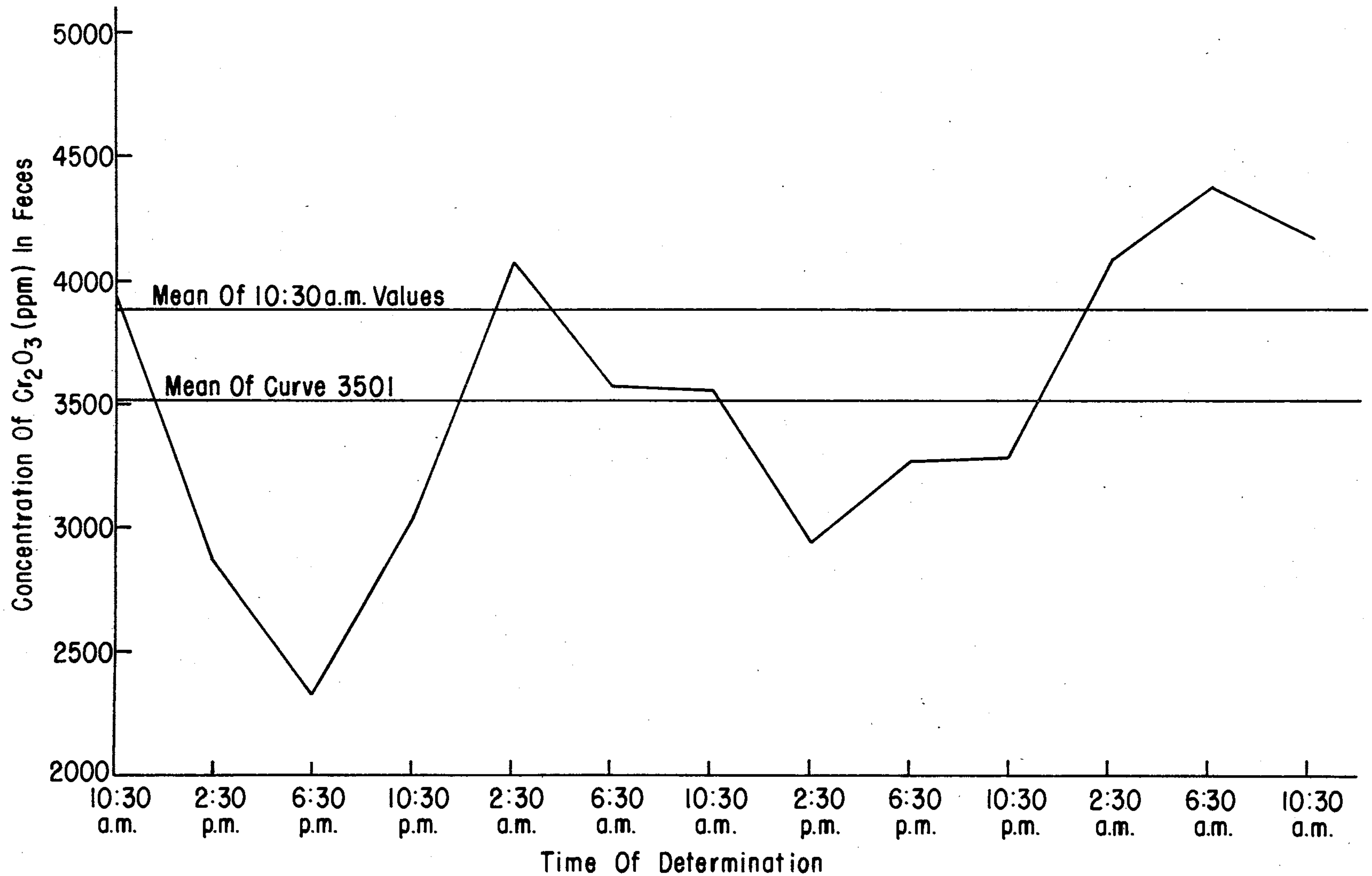

Figure 6. Diurnal Excretion Curve of Chromic Oxide for Cows in July on High Level of N.

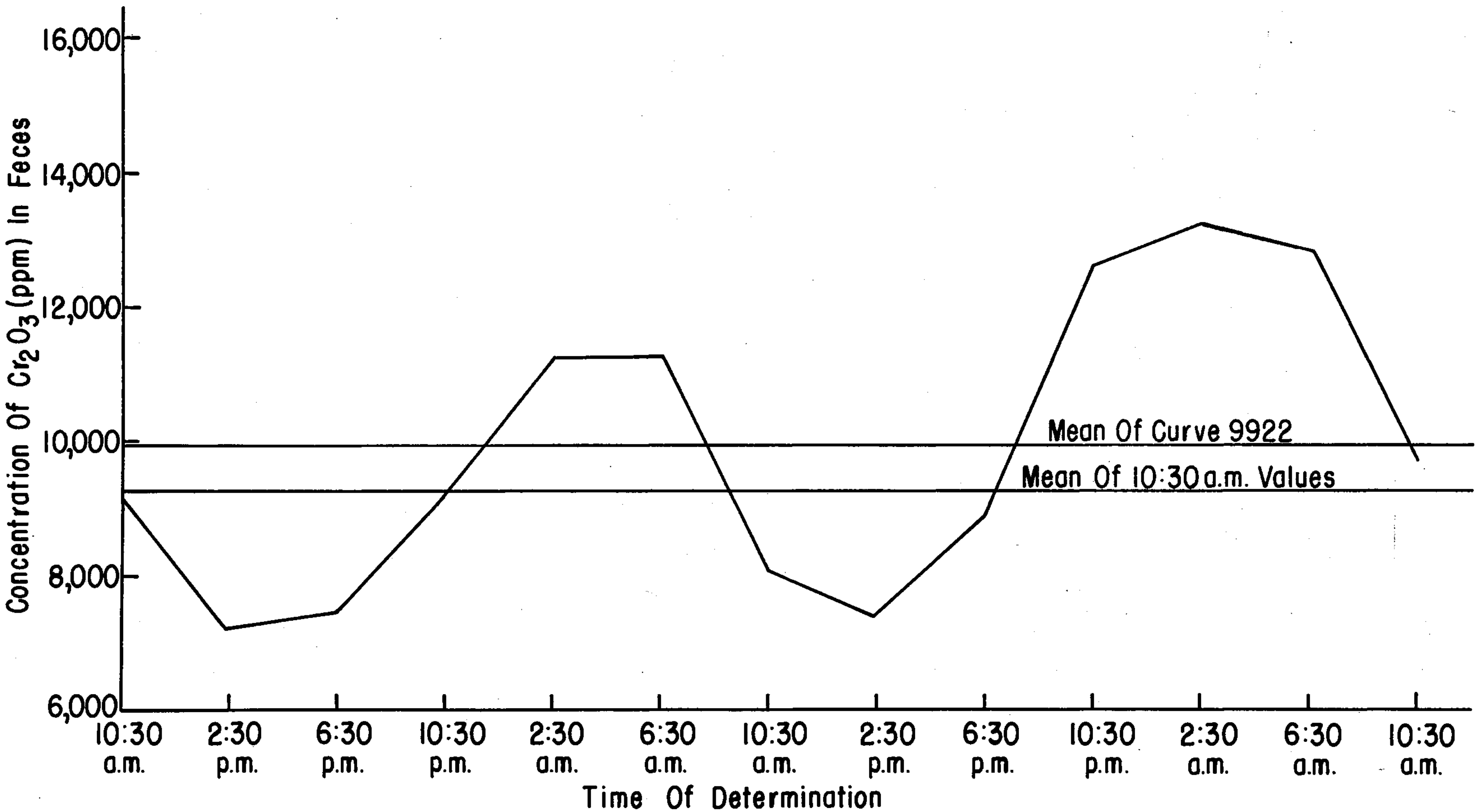

Figure 7. Diurnal Excretion Curve of Chromic Oxide for Calves in July on Low Level of N.

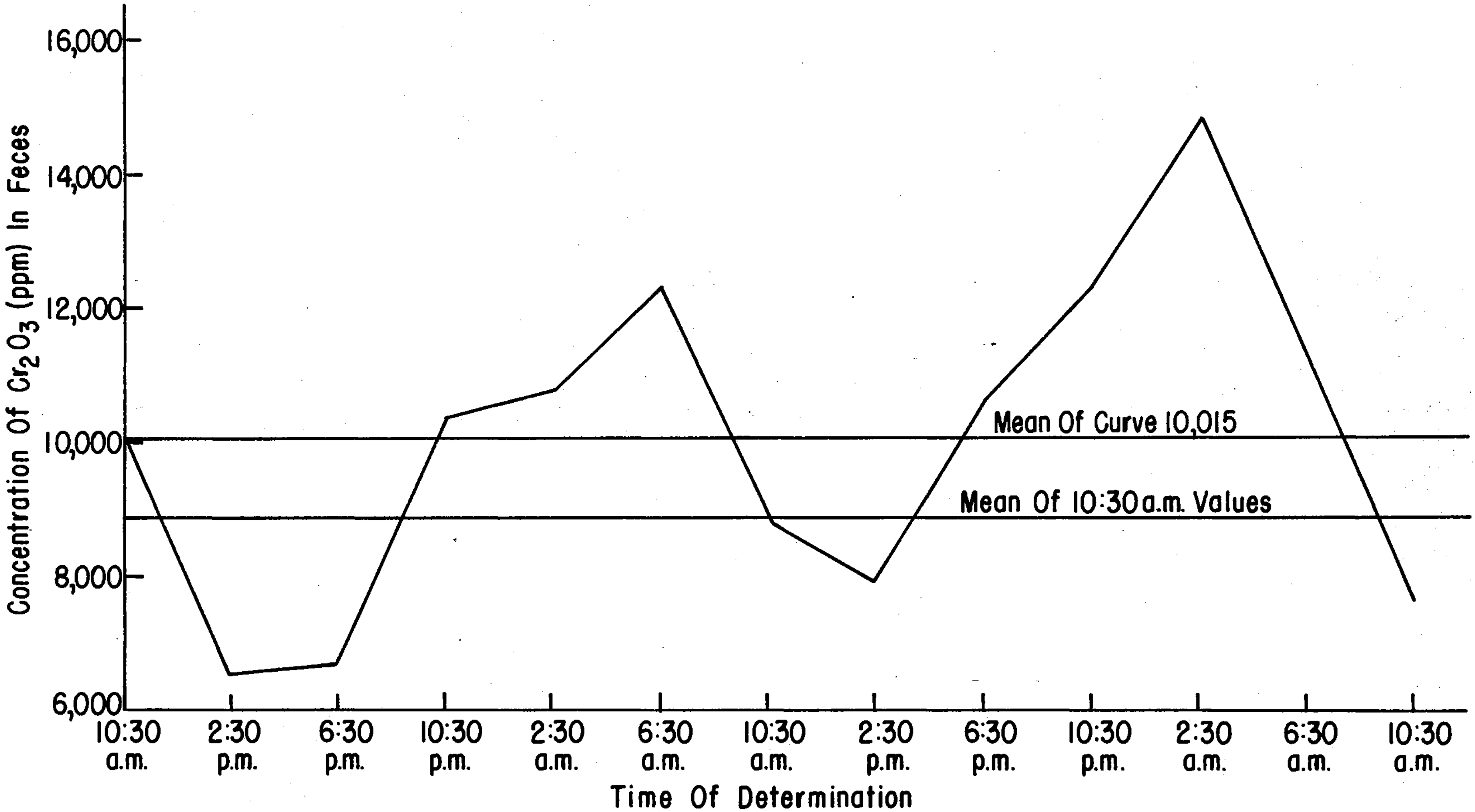

Figure 8. Diurnal Excretion Curve of Chromic Oxide for Calves in July on Medium Level of N.

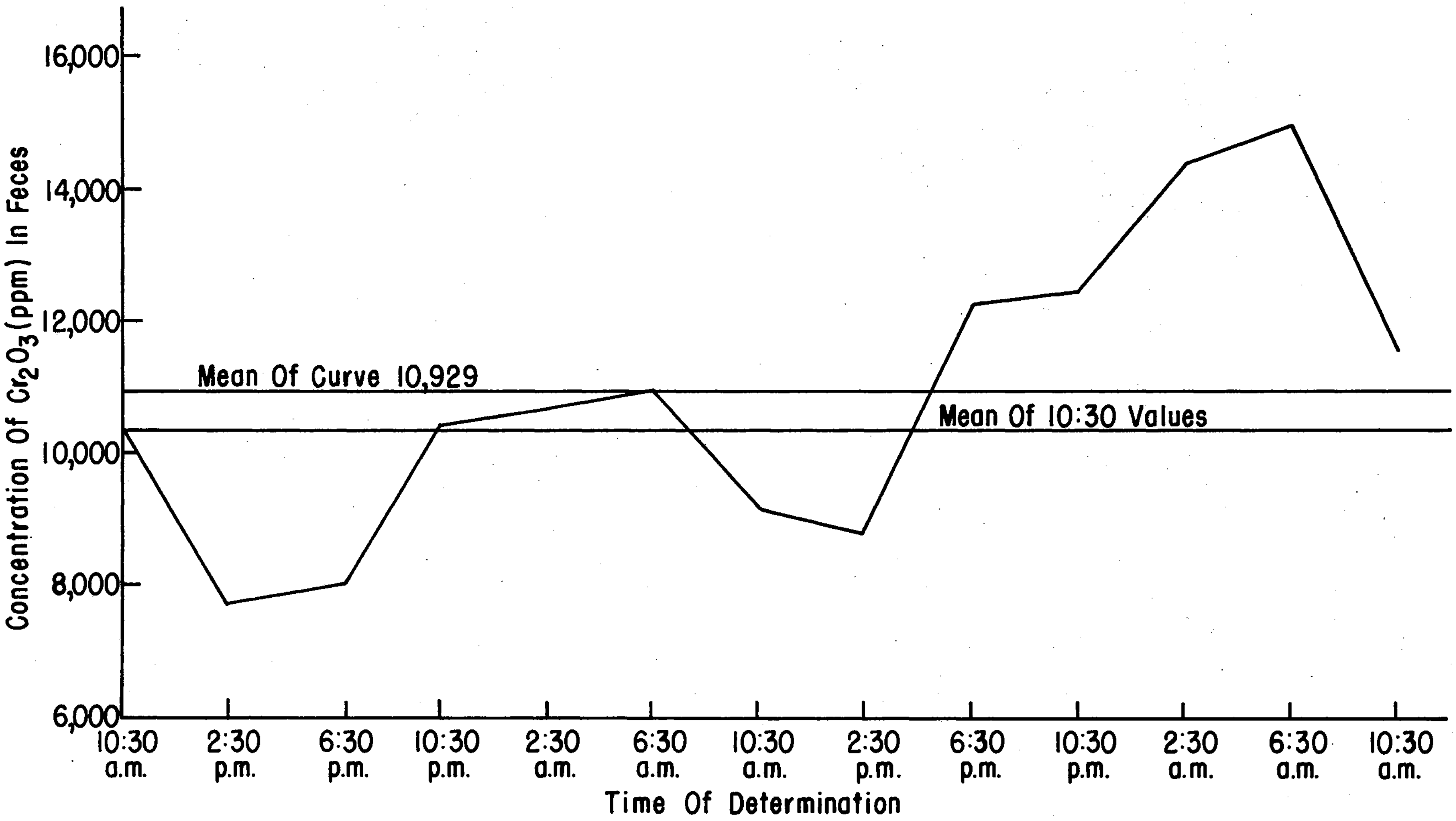

Figure 9. Diurnal Excretion Curve of Chromic Oxide for Calves in July on High Level of N.

VITA

James Pat Telford

Candidate for the Degree of

Master of Science

Thesis: THE EFFECTS OF VARYING LEVELS OF NITROGEN FERTILIZATION UPON YIELD AND COMPOSITION OF MIDLAND BERMUDAGRASS AND ITS SUBSEQUENT PASTURING VALUE TO COWS AND CALVES

Major Field: Animal Science and Industry

Biographical:

Personal Data: Born in Ardmore, Oklahoma, July, 31, 1949, the son of Pat and Millie Telford.

Education: Received the Associate Science degree from Murray State College, Tishomingo, Oklahoma, May, 1969. Received the Bachelor of Science degree from Oklahoma State University, Stillwater, Oklahoma, May, 1971, with a major in Animal Science.

Experience: Raised and worked on a livestock ranch in southern Oklahoma; worked at Texas County Feedyards, Guymon, Oklahoma, 1971; Graduate Student at Oklahoma State University 1971-73.

Member: Alpha Zeta, Alpha Gamma Rho Fraternity and American Society of Animal Science.