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THE INTAKE AND DIGESTIBILITY OF INTAKE FOR LACTATING ANGUS COWS GRAZING FESCUE-LEGUME AND FESCUE PASTURES

A Thesis

Presented for the

Master of Science

Degree

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Johnny Dale Beaty

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ABSTRACT

Forty mature lactating Angus cows were allotted to fescue-legume or fescue pastures. Within pasture quality, cow size was intentionally confounded with pastures so that large cows were bred to large bulls. Each cow was fed 10 g Cr_2O_3 in 263 g of feed at each of two feedings (8:00 a.m. and 5:00 p.m.) per day for 155 days (April 26-September 28). Fecal samples collected were analyzed for chromium and acid detergent lignin (ADL). Forage ADL was estimated by the cage and strip method simultaneously. Regression was used to predict DM intake/day (DMI), digestibility (DIG) and digestible DM intake/day (DDM) for each cow (mean values for period). Digestibility of fescue-legume was 4% higher ($P < .05$) than fescue (58 vs 54%). Cows grazing fescue-legume pastures consumed 2 kg more ($P < .01$) DM and 1.5 kg more DDM ($P < .01$) than cows grazing fescue (10 vs 8 kg DM and 5.9 vs 4.4 kg DDM). Larger values for cows grazing fescue-legume resulted from advantages during the last of the period. Only small differences were detected during the first 40 days. Cows on fescue-legume used the extra nutrients to maintain 10 kg more ($P > .05$) weight, to gain 30 kg more ($P < .05$) weight, and to gain 2.1 mm more ($P < .05$) subcutaneous fat, but produced similar amounts of milk ($P > .10$). Cows on fescue-legume, however, weaned 16 kg more calf ($P < .10$). Cows grazing fescue-legume pastures had 65% of the variation in forage DM intake accounted for by milk production and seasonal cow weight, while for cows grazing fescue pastures this

model accounted for only 44% of the variation in forage DM intake. For cows grazing fescue-legume pastures it appears that cow weight, cow weight change and milk production were much more important in explaining the variation in forage DM intake than they were for cows grazing fescue pastures.

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CHAPTER I

INTRODUCTION

A major goal of cow-calf producers is to maximize production of beef per acre from available forage. This is often done most efficiently in Tennessee by utilizing the many acres of available permanent pastures of tall fescue. These pastures provide year round grazing for most beef cow herds in Tennessee. Fescue provides ample nutritious forage for cattle except in the summer when it becomes dormant. This problem has been managed by many cattlemen by renovating fescue pastures in late winter with legumes to provide for grazing needs in the summer months.

This experiment's objective was to determine the differences in feed intake and production and other variables affecting beef production for cows grazing fescue and fescue-legume pastures.

CHAPTER II

LITERATURE REVIEW

It has been well established that when adequate feed resources are available, mature animals consume feed at constant rates and maintain body weight at nearly constant levels for long periods of time. Bines (1969) concluded that these phenomena imply a long-term regulatory mechanism of feed intake. Blaxter *et al.* (1966), Hutton (1962), McCullough and Russell (1962), Balch and Campling (1962), Baile and Pfander (1964), Montgomery and Baumgardt (1965) and Conrad *et al.* (1964) agree that factors influencing voluntary intake vary according to digestibility of the diet. When digestibility was less than 67%, feed intake was related to physical control factors (body weight, undigested residue per unit body weight, rate of passage and dry matter digestibility. When digestibility was greater than 67%, feed intake was related to physiological control factors (metabolic size, production and digestibility). Regulation of feed intake as it applies to balanced rations is discussed here. Possible physical factors affecting voluntary intake as well as the physiological regulatory mechanisms of lipostatic, chemostatic and thermostatic, will be reviewed.

Physical Factors Affecting Intake

The fibrous and bulky nature of some feeds consumed by ruminants lend emphasis to the idea that gut size and/or physical

distention can limit feed intake for some rations. These limits represent the most probable limitations of milk production as well as rate of growth for dairy cows consuming rations of low energy density (Conrad *et al.*, 1964). McCullough (1959) and Huffman (1961) reported a high correlation between milk production and feed intake for cows. Alden (1968) also reported a relationship between wool production and intake for sheep consuming low quality forages. Blaxter *et al.* (1966) with sheep and Baumgardt (1967) with cattle reported that the efficiency of milk production increased with increasing digestible energy intake to the point where fat deposition and milk production plateau. As intake increased beyond this point the efficiency of production increases at a decreasing rate due to decreasing digestibility, increasing amounts of energy diverted to fat and the amount of heat increment lost. Conrad *et al.* (1964) postulated that if the capacity of the abdominal cavity limits feed intake, then the dry matter intake would be proportional to body weight. The idea that voluntary intake of feed is limited by the physical capacity of the gut comes from research pointing to the relationships between voluntary intake, rumen fill, and rate of passage (Campling, 1966).

Feed Intake and Rumen Fill

Several researchers have shown that when ruminants are offered forages, they eat to a constant fill (Blaxter *et al.*, 1961; Freer and Campling, 1963; and Conrad *et al.*, 1964). Campling and Balch (1961) and Carr and Jacobson (1962) removed hay from the cardia,

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resulting in an increased consumption of 177% in cattle. They also placed large bladders of water in the rumen and observed a 0.54 lb decrease in intake for each 10 lbs of water in the bladders. They concluded that the amount of rumenoreticulum contents has a direct effect on consumption of feed. Boling *et al.* (1967), employing polyethylene as a dietary dilutant, reported that cattle tended to increase their feed intake as nutrient density decreased in an attempt to meet energy requirements. At low nutrient densities energy requirements were not met due to rumen capacity limitations. Palatability did not affect intake. In this experiment Montgomery and Baumgardt (1965) fed rations varying in energy density and physical form to dairy heifers and found that as energy density increased, intake and rumen retention time increased, cellulose digestibility decreased and therefore rumen fill increased. Tayler (1959) working with cattle observed that the gravid uterus of the pregnant cow and internal fat deposits could serve to limit capacity of the rumen. Forbes (1968) found that rumen volume was not appreciably depressed until the last five weeks of pregnancy in sheep. Abdominal fat was an important factor in the depression of rumen capacity of pregnant ewes because of the competition for space. Pettyjohn *et al.* (1963) observed that ruminants strive to maintain a certain caloric intake on low energy diets but are limited by rumen capacity.

Feed Intake and Rate of Passage

Several researchers have shown that when cattle and sheep are fed long forages they eat to similar rumen fills and intake is directly related to their respective rate of disappearance from the rumenoreticulum (McCullough and Russell, 1959, 1962). Campling, Freer and Balch (1961) found that when cattle were fed oat straws and long hay, voluntary intake was regulated in a manner proportional to the respective rate of disappearance from the tract. Montgomery and Baumgardt (1965) found that increased energy density of the diet resulted in an increase in retention in the tract. Campling and Balch (1961) found that intake was related positively to the rate of disappearance from the tract. Weston and Hogan (1968) infused casein into the rumen of sheep and observed that intake was related to the resistance of the organic matter to digestion and subsequent removal from the digestive tract.

Physiological Factors and Feed Intake

As noted by Conrad *et al.* (1964) and Pettyjohn *et al.* (1963), beyond a digestibility of 67%, rumen distention or physical factors cease to control voluntary intake. At this level of digestibility, physiological factors become important as controlling mechanisms of voluntary intake. These factors include lipostatic, thermostatic and chemostatic effects.

Thermostatic Control of Feed Intake

Evidence of feed intake regulation by thermostatic mechanisms was reported by Conrad (1964) and Strominger and Broleck (1953)

who concluded that an increase in heat due to the calorigenic value of the diet can result in decreased intake. Kleiber (1961) found that the degree that high environmental temperatures influences intake is associated with the calorigenic effect of the diet. Ragsdale *et al.* (1949, 1950, 1951) working with cattle and Appleman and Delouche (1958) with goats observed that with increasing environmental temperatures there was a corresponding decrease in intake.

Chemostatic Control of Feed Intake

Another mechanism thought to control feed intake is that of chemostatic regulation or regulation by blood metabolites acting on the hypothalmus (Conrad *et al.*, 1966). Mayer (1953) observed with rats, mice and dogs that injections of glucose brought about temporary decreases in intake. The hypothalmus responded to the increases in blood glucose causing a negative feedback on intake. He therefore proposed a glucostatic mechanism for regulation of energy intake. He emphasized that this does not exclude the possibility of the role of other metabolites in this type of short term regulation. Manning *et al.* (1959) reported no effect on intake for mature ewes and concluded that glucose was not involved in the short term regulation of intake in ruminants. Simkins *et al.* (1965a) supported this conclusion in research with cattle. Baile and Mayer (1968) reported that goats did not increase intake to correct insulin induced hypoglycemia. These reports suggest that while there is a

gluostatic mechanism for regulation of food intake for monogastric animals, the theory does not apply to ruminants.

However, Simkins *et al.* (1965b) found that intraruminal injections of acetate, propionate, butyrate, and a mixture of the volatile fatty acids decreased intake of pelleted hay rations in dairy cattle. He concluded that these and possibly other metabolites act as satiety signals for the hypothalmus. Baile and Mayer (1968) experimented with both intraruminal and intravenous injections of acetate in goats and found that intraruminal injections depressed intake while the intravenous injections did not. They proposed that receptors sensitive to acetate levels are located on the lumen side of the rumenoreticulum.

Bhattacharya and Warner (1968) found that intraruminal infusions of acetate reduced hay consumption of dairy heifers by 39%. Substituting a portion of the infused acetic acid with an equicaloric amount of propionate partially lessened the degree of intake depression. Following this with the addition of citrate alleviated the depressed intake. They concluded that the balance of volatile fatty acids in the rumen are important in controlling feed intake. Montgomery *et al.* (1963) working with cattle and Ulyatt (1965) working with sheep found that intraruminal infusions of volatile fatty acids caused small changes in blood levels but the subsequent decreases in food intake were probably due to the influence of the acids on receptors located in the lumen side of the rumenoreticulum. This was also postulated by Baile and Mayer (1968), with goats.

Thye *et al.* (1969) reported that acetate, propionate and glucose levels in the blood were poorly correlated to feed intake. They found that butyrate and free fatty acids were most highly correlated to subsequent voluntary feed intake.

Thye *et al.* (1969) also found that long chain fatty acid concentration at seven hours after feeding was a better indicator of subsequent feed intake (r^2 = .50) than the volatile fatty acids in the blood. Simkins *et al.* (1965b) and Radloff *et al.* (1966) found a relationship between the concentration of long chain free fatty acids in the blood and feed intake. Radloff *et al.* (1966) observed that after fasting, free fatty acid concentration increased. However, Baumgardt *et al.* (1964) found a moderate correlation (R^2 = .63) between feed intake in dairy cows and venous blood acetate levels. Also, the peak venous blood levels coincided with peak rumen levels for acetate.

Lipostatic Control of Feed Intake

Kennedy (1953) postulated a lipostatic theory of voluntary feed intake regulation. His theory, which resulted from experimentation with rats, was that unknown chemicals released in proportion to body size, inhibit feed consumption. Therefore, over a period of time feed intake is reduced as the animal fattens until only the maintenance requirements are met. Schinckel (1960) observed a decline in the *ad libitum* intake of sheep associated with increasing fatness. Hutton (1962) found that for mature dry cows a rapid rate of fattening was followed by a decline in intake. Graham (1969)

observed a decline in feed intake of sheep with increasing fatness. Mayer (1953), Howarth *et al.* (1968) and Reid *et al.* (1971) all found that an increasing degree of fatness was associated with decreasing levels of intake. Hervey (1969) postulated that the unknown chemical compound suggested by Kennedy (1953) may be an adrenal glucocorticoid and may provide a signal from the adipose tissue to the hypothalmus decreasing feed intake.

As a long-term mechanism of feed intake regulation, the lipostatic theory seems likely since day to day variations in intake must be corrected by a long-term control mechanism (Baumgardt, 1969).

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CHAPTER III

INTAKE AND DIGESTIBILITY OF INTAKE FOR LACTATING ANGUS COWS GRAZING FESCUE-LEGUME AND FESCUE PASTURES

I. SUMMARY

The daily DM forage intake and digestibility of DM intake was estimated over the spring and summer for 40 mature lactating Angus cows utilizing the chromic oxide-acid detergent lignin ratio technique. Cows grazed either fescue or fescue-legume pastures with cow size confounded with pasture within pasture quality. Cow weight, cow fat, milk production and calf weight were measured monthly. Fescue pastures were allowed to mature while fescue-legume pastures were maintained in a vegetative state by regular mowing.

Cows grazing fescue-legume pastures consumed more forage DM ($P < .01$) that was of higher digestibility ($P < .01$) and weaned heavier calves ($P < .07$) than cows grazing fescue pastures. Cows on fescue-legume pastures also gained more weight and more subcutaneous fat ($P < .01$) while giving similar amounts of milk. These results suggest that differences in weaning weights were due to non-milk nutrients being more plentiful for calves on fescue-legume pastures. The variables cow weight and cow weight change accounted for a significant ($P < .01$) part of the variation. These variables were not important ($P > .10$) in explaining variation in forage intake for cows grazing fescue pastures. For cows grazing fescue-legume pastures milk production and cow weight accounted for 65% of the variation ($P < .01$) in forage consumption but only 44% of

the variation in intake was explained for cows grazing fescue pastures. For cows grazing both fescue-legume and fescue pastures, the regression of cow weight and milk production on forage digestibility explained little of the variation in digestibility.

II. INTRODUCTION

Feed consumption and its utilization have been important research topics for a long time. The factors that regulate the consumption of feed by cattle grazing pastures has been discussed by many researchers (Baumgardt, 1969; Conrad *et al.*, 1964; Campling, 1969). Most of this work with pasture intake has been conducted with small numbers of animals for short intensive periods, and the animals used have been quite varied in physiological condition (i.e., pregnant, lactating, growing), Alden and Young, 1964; Brannon *et al.*, 1954; Brumby, 1959; Corbett *et al.*, 1963). The purpose of this research is to: (1) estimate forage intake and digestibility of intake for lactating Angus cows grazing high quality and low quality pastures, (2) determine level of production of cows and calves on fescue-legume and fescue pastures, and (3) determine factors that influence intake of cows grazing fescue-legume and fescue pastures.

III. MATERIALS AND METHODS

Forty mature lactating Angus cows were allotted to two types of pasture managed to produce two distinct levels of forage quality. The cows, selected to approach the range of variation in milk

production and mature fall weight for Angus cows, were employed in a stratified randomization based on mature fall weight and progeny weaning weights. The purpose of this randomization was to insure a large variation in cow weights and milking ability in both pasture qualities. Within pasture quality, cows were allotted to two 20-acre pastures according to cow fall weight (ten cows/ pasture). Cow size (weight) was intentionally confounded with pasture so that large cows could be mated to large bulls.

The low quality pastures consisted of a homogenous sward of tall fescue (Festuca arundinaceae) and was managed to allow the forage to mature. The high quality pastures consisted of tall fescue (approximately 70% of available forage) and red clover (Trifolium pratense, approximately 30% of available forage). This pasture was maintained in a vegetative state by regular mowing.

Total fecal dry matter (DM) production was estimated for each cow for a period of 152 days (April 29-September 28) by the CR_2O_3 dilution method of Linkous *et al.* (1954). During this period each cow was fed 263 g in a pelleted feed containing 9.5 g CR_2O_3 twice a day at approximately 8:00 a.m. and 5:00 p.m.

The cows were fed in individual stalls and remained in the stall no longer than ten minutes. Most cows consumed all of the feed allowed them, but any that didn't were bolused.

One fecal sample of approximately 150 g was collected from each cow morning and night each week (1,760 samples) during the feeding period. Fecal samples were frozen until dry matter

(A. O. A. C., 1970), chromium (Williams *et al.*, 1962), acid detergent fiber and acid detergent lignin (Van Soest and Wine, 1967) determinations were made. No estimates of forage intake or fecal output other than the CR_2O_3 dilution technique were made.

Cow weight and fatness were measured during the fall of the year and once monthly during the experimental period. Fatness was measured ultrasonically at the 12th rib (Swaim *et al.*, 1966). Linear regression equations were employed to predict the relationship between cow weight and time and cow fat and time. These equations were evaluated for times at the beginning and end of the experimental period. Cow weight and fat change were calculated from the equations:

Equation 1: Ending Weight - Beginning Weight

Equation 2: Ending Fat - Beginning Fat

Height at the withers was also measured with linear calipers during the fall prior to the experimental period. Cow milk productions were estimated monthly during lactation for a total of seven estimates utilizing the calf suckle technique (calves were separated from their dams at 6:00 P. M. and weighed before and after suckling at 6:00 A.M.). These values were corrected to a 24-hour equivalent by the method of Hendrix (1967) and were averaged to obtain one estimate of milk production per cow.

Calves were castrated in April. They were weighed at birth and at weaning.

Samples for pasture analyses were obtained by the cage and strip procedure described by Linehan (1952). Five nine square foot caged

areas (cages) and five forty-two square foot uncaged areas (strips) were harvested randomly from each pasture. These measurements were taken only from areas where the cows had obviously been grazing. This procedure was performed approximately every two weeks during the period. Random samples from these cage and strip clippings were analyzed for dry matter (DM), acid detergent fiber (ADF) and acid detergent lignin (ADL) by methods described previously. Values for each cage and each strip for each two-week period were averaged and these values were used to estimate both the percent acid detergent lignin in forage consumed and percent acid detergent lignin in available forage (Carver *et al.*, 1975). Regression procedures were used to estimate percent ADL (g ADL/g available or consumed forage dry matter) for each pasture. Percent ADL in available forage is shown in Appendix Table A-1 and Figure 1. The model employed for estimating ADL over time was Equation 3:

$$\text{Forage \% ADL (g ADL/g forage DM)} = b_0 + b_1 (\text{time}) + b_2 (\text{time})^2$$

Morning and evening fecal ADL percentages for each cow were averaged on a daily basis to arrive at an average percent ADL in the feces $\frac{(\text{g ADL})}{(\text{g fecal DM})}$. These average values were employed as a data set in regression procedures for estimating percent ADL in fecal dry matter for each cow over the grazing period. The model employed was Equation 4:

$$\text{Fecal \% ADL (g ADL/g fecal DM)} = b_0 + b_1 (\text{time}) + b_2 (\text{time})^2$$

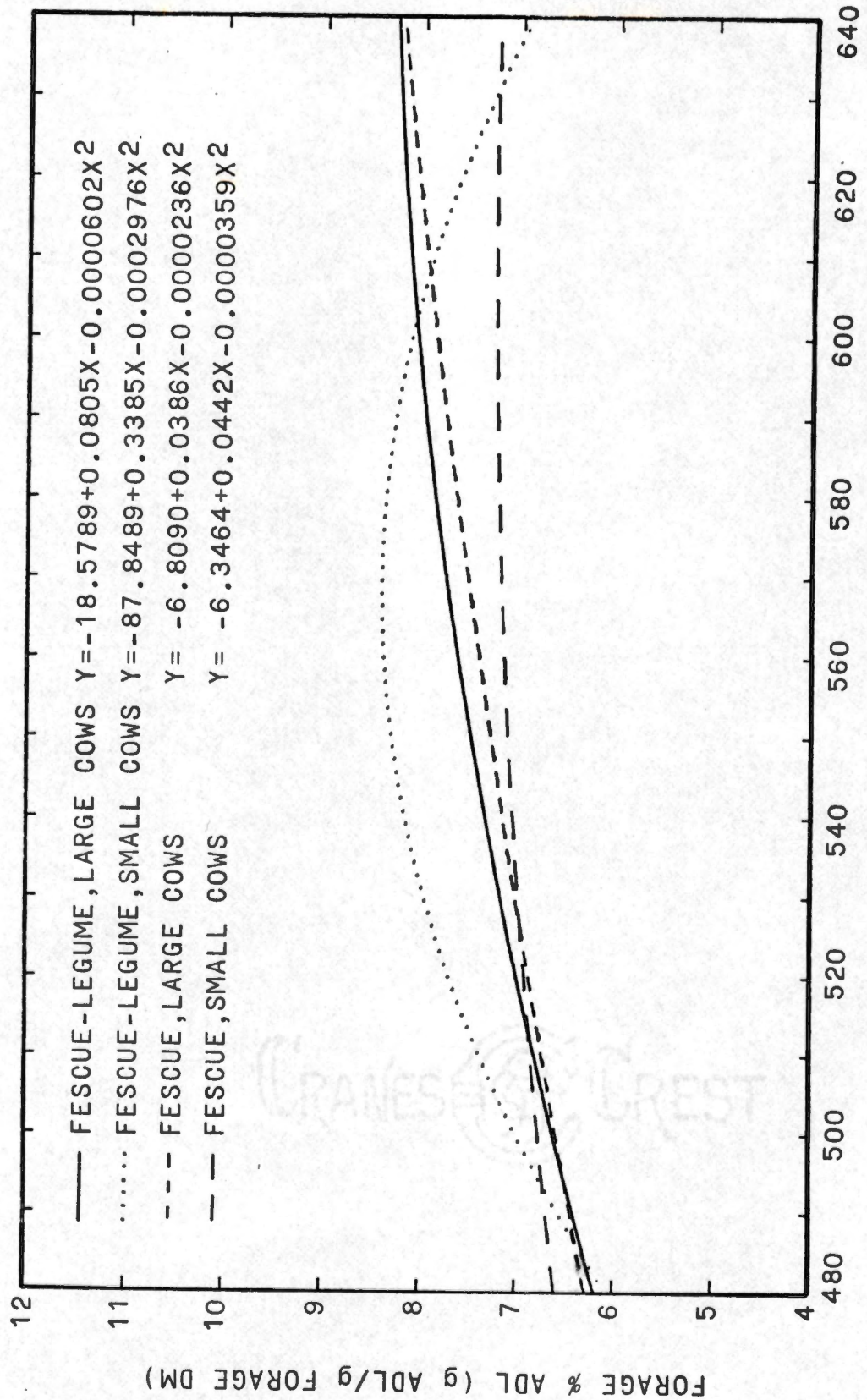


Figure 1. % ADL in available forage.

The respective equations for each cow are presented in Appendix Table A-2 and the regression equations for each pasture are shown in Figure 2.

Average percent CR_2O_3 in feces (mg CR_2O_3/g fecal DM) was calculated by the method of Hopper *et al.* (1976).

Equation 5: Avg % Chromium in fecal DM (mg CR/g fecal DM) = ((mg CR/g fecal DM from a.m. sample) + (mg CR/g fecal DM from p.m. sample))/2

Equation 6: Avg % CR in fecal DM adjusted for diurnal excretion (mg CR/g fecal DM) = 0.043 + 0.968 (Avg % CR in fecal DM)

Equation 7: Avg % CR_2O_3 in fecal DM adjusted for diurnal excretion + Avg % CR in fecal DM adjusted for diurnal excretion/.6842 mg CR/mg CR_2O_3

These values for average percent CR_2O_3 in fecal DM were employed as a data set in regression procedures for estimating the percent CR_2O_3 in fecal DM for each cow over the grazing period. The model employed was Equation 8:

$$\% \ CR_2O_3 \text{ in fecal DM (mg } CR_2O_3\text{/g fecal DM)} = b_o + b_1 \ (\text{time}) + b_2 \ (\text{time})^2$$

Models for each cow are presented in Appendix Table A-3 and for each pasture in Figure 3.

The main differences in trends for fecal chromic oxide and fecal and forage ADL over time were between pasture qualities and therefore pasture within pasture quality differences will be ignored.

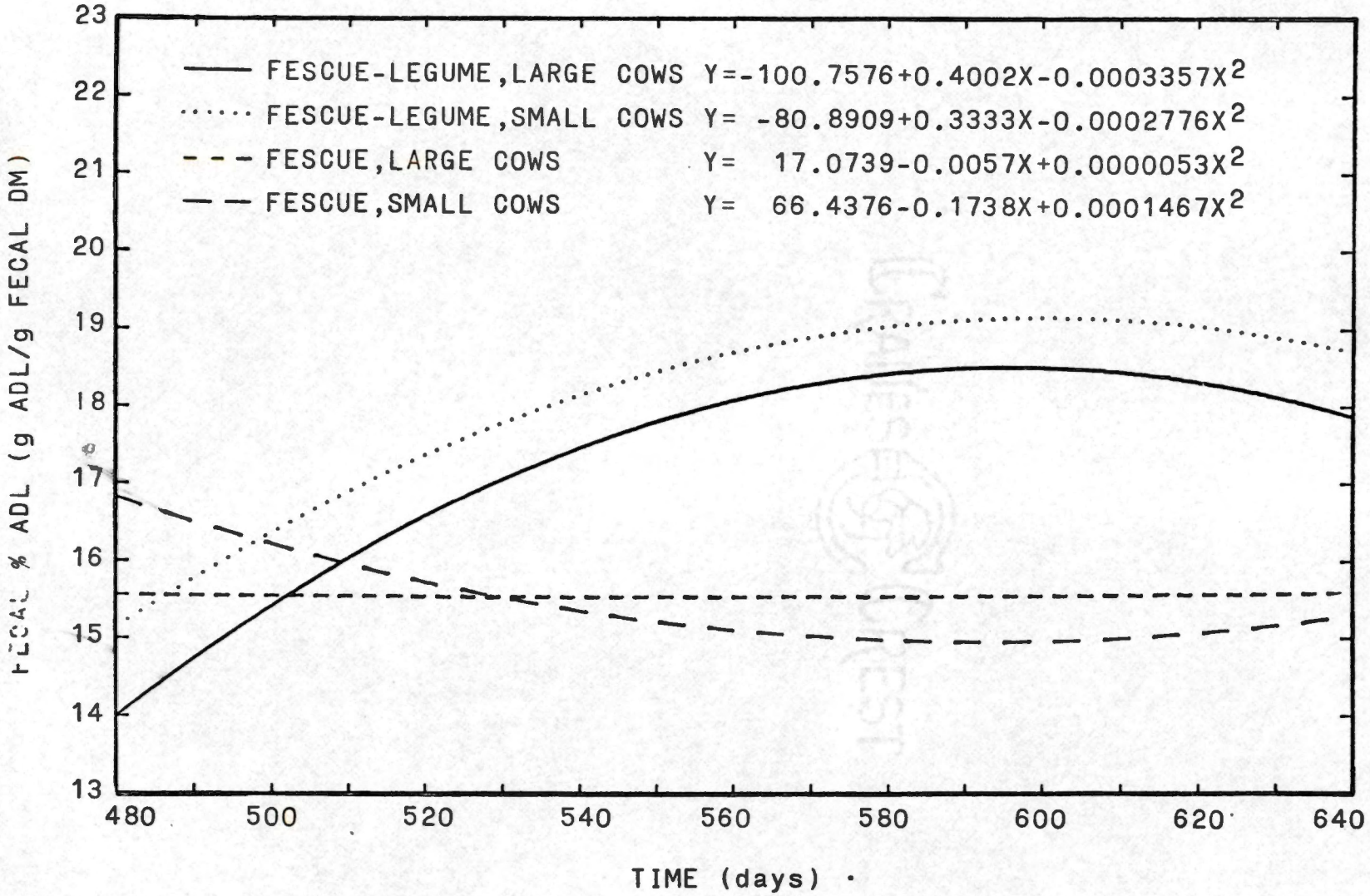


Figure 2. Fecal lignin by pasture.

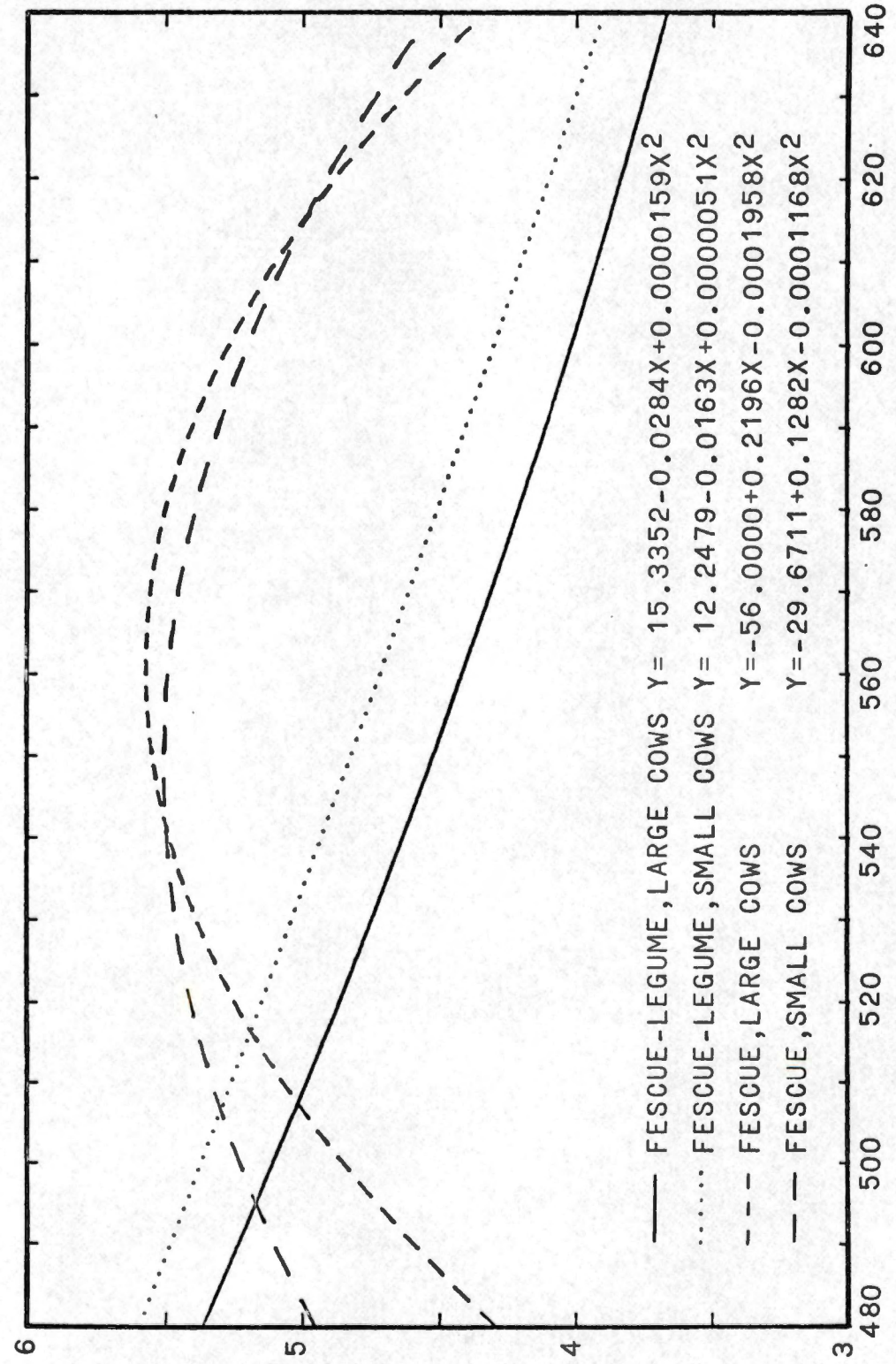


Figure 3. % CR_2O_3 in fecal DM.

The regression equations estimating percent CR_2O_3 in fecal DM, percent ADL in fecal DM and percent ADL in forage DM were employed in calculating fecal output/day, dry matter forage intake/day, apparent indigestibility and apparent digestibility for each cow. The respective formulas are (Crampton and Harris, 1969):

Equation 9: Fecal DM output (kg/day) = 19 g CR_2O_3 in feed/(fecal % CR_2O_3)(mg CR_2O_3/g fecal DM)(.000001)

Equation 10: % digestibility of forage DM = $\frac{.9278 \text{ g DM/g forage air DM}}{.9499 \text{ g DM/g fecal air DM}}$ (forage ADL (g ADL/g forage DM)/fecal ADL (g ADL/g fecal DM))

Equation 11: % forage indigestibility = 1.0 - % digestibility of forage DM

Equation 12: Forage DM intake (kg/day) = $\frac{\text{fecal DM output (kg/day)}}{\text{\% indigestibility of forage DM}}$

Equation 13: Digestible DM forage intake = (forage DM intake)(% forage digestibility)

The regression equations (Equations 3, 7 and 9) described above were evaluated simultaneously for each day during the experimental period. From these values percent forage digestibility, forage DM intake and digestible DM forage intake were calculated for each cow for each day of the period. Regression equations describing the nature of percent digestibility of forage DM, forage DM intake and digestible DM forage intake over the experimental period are shown in Appendix Tables A-4, A-5 and A-6. These calculated values were used to determine the mean percent digestibility of forage DM, mean

forage DM intake and mean digestible DM forage intake. These values, in turn, were employed as a data set in analyses of variance procedures.

IV. RESULTS AND DISCUSSION

Forage Dry Matter Intake

Cows grazing fescue-legume pastures consumed more forage dry matter as an average of the grazing season than did those grazing fescue-pastures ($P < .01$, Table 1). Figure 4 shows the relationship between forage DM intake and time for cows grazing fescue-legume and fescue pastures. Forage consumption for cows grazing the two pasture qualities were similar during the early spring, but intakes of cows grazing fescue-legume pastures increased over the grazing period, while intakes for cows grazing fescue pastures decreased until around the first of August and then started increasing. Pasture within pasture quality did not significantly affect intake ($P < .05$, Table 2). These consumption levels are on the low end of the NRC requirements.

Percent Forage Digestibility

Cows grazing fescue-legume pastures consumed forage that was 3.7 percentage units higher in digestibility, as an average over the grazing season ($P < .01$), than did cows grazing fescue pastures (Table 3).

Average digestibility was 1.4 percentage units ($P < .05$) different between pastures within the fescue pasture quality. No differences were detected ($P < .05$) for pasture within fescue-legume

TABLE 1

FORAGE CONSUMPTION OF COWS GRAZING FESCUE-LEGUME AND FESCUE PASTURES[a]

	Fescue-Legume		Fescue	
	$\bar{X}$	SD	$\bar{X}$	SD
Forage DM Intake (kg/day)	10.09[b]	.6388	8.06[c]	.6687
Forage Digestible DM Intake (kg/day)	5.87[b]	.3822	4.39[c]	.3746

[a]Means were separated by Duncan's New Multiple Range Test Procedure (Snedecor and Cochran, 1967).

[b,c]Means on a line with different superscripts differ significantly ($P < .01$).

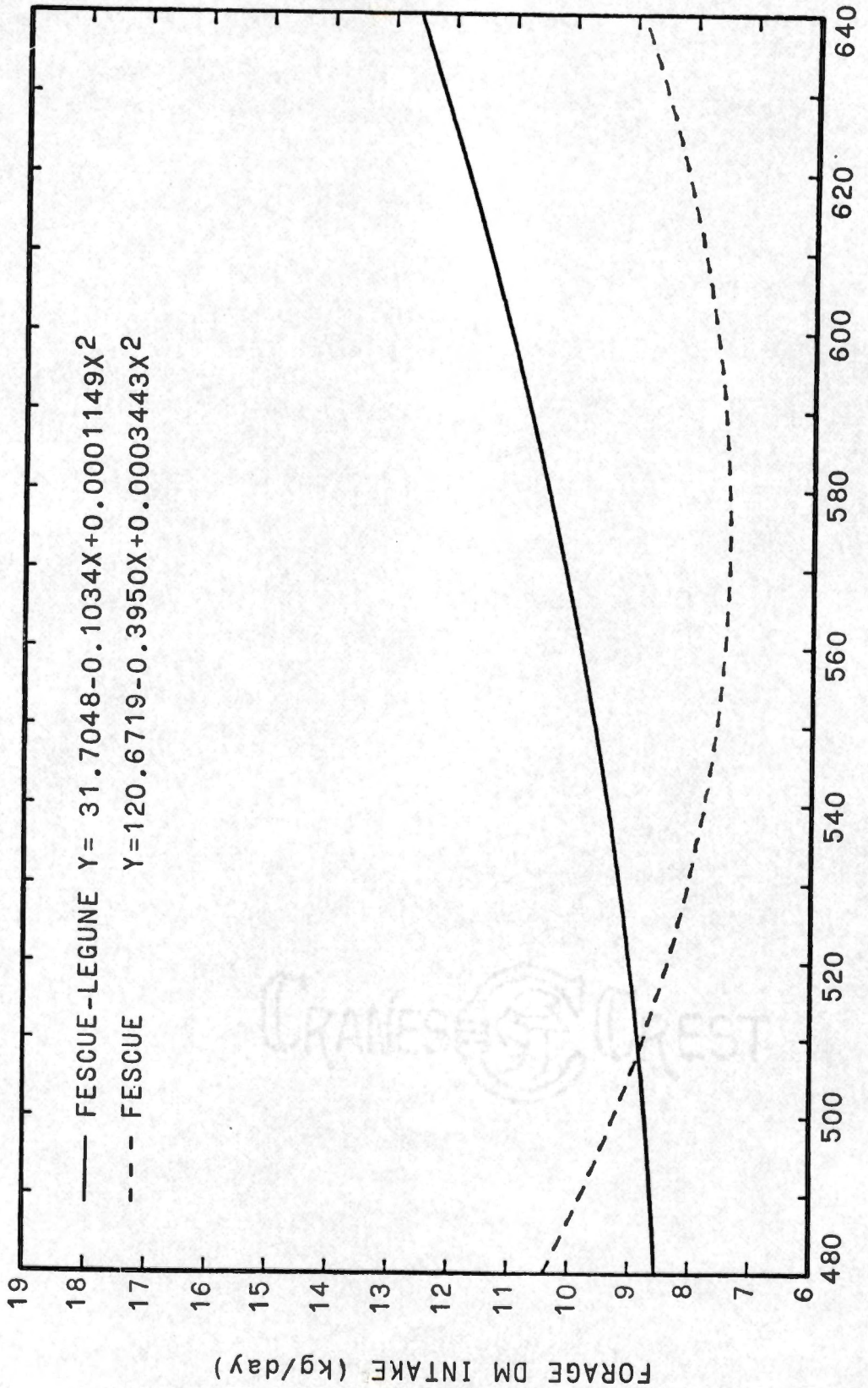


Figure 4. Forage DM intake by pasture quality.

TABLE 2

FORAGE CONSUMPTION OF COWS GRAZING EXPERIMENTAL PASTURES[a]

	Fescue-Legume				Fescue			
	Large Cows		Small Cows		Large Cows		Small Cows	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Forage DM Intake (kg/day)	10.33[b]	.5035	9.84[b]	.6889	8.00[c]	.5767	8.11[c]	.7767
Forage Digestible DM Intake (kg/day)	6.01[b]	.2951	5.73[b]	.4220	4.31[c]	.3662	4.47[c]	.3856

[a]Means were separated by Duncan's New Multiple Range Test Procedure (Snedecor and Cochran, 1967).

[b,c]Means on a line with different superscripts differ significantly ($P < .01$).

TABLE 3

PASTURE QUALITY CHARACTERISTICS[a]

	Fescue-Legume		Fescue	
	$\bar{X}$	SD	$\bar{X}$	SD
Percent Forage ADL	7.60[b]	1.12	7.17[b]	.685
Percent Forage Digestibility	58.03[c]	.0123	54.33[d]	.0127

[a]Means were separated by Duncan's New Multiple Range Test Procedure (Snedecor and Cochran, 1967).

[b]Means on a line with different superscripts differ significantly ($P < .05$).

[c,d]Means on a line with different superscripts differ significantly ($P < .01$).

pasture quality (Table 4). The difference in digestibility between pastures within fescue pasture quality was, however, quite small when compared to the difference between pasture qualities. Over the grazing period, digestibility of forage consumed from fescue-legume pastures remained stable. Digestibility of forage consumed from fescue pasture, however, decreased over the season (Figure 5). Buckner (1967), Hinds *et al.* (1967) and Brannon *et al.* (1954) found that digestibility of fescue pastures decreased from spring levels during the summer then increased in the fall. Barth *et al.* (1972) found that the digestibility of fescue-legume pastures decreased slightly until June and then increased slightly and non-significantly through September. McCullough and Russell (1962) found that digestibility of forage is related to stage of maturity in that as the summer progressed digestibility decreased. Barth *et al.* (1972) found digestibility of fescue-legume to be around 60% for the summer months.

Forage Digestible Dry Matter Intake

Forage digestible DM intake was 1.5 kg/day higher ($P < .01$, Table 1) for cows grazing fescue-legume pastures than for those allowed fescue pastures. As shown in Figure 6 digestible DM intake for cows grazing the two pasture qualities during the early spring are similar but become increasingly different as the season progressed, as a result of the gradual increase in intake by cows grazing fescue-legume pastures with little change in digestibility and the gradual decrease in intake and digestibility of intake for cows grazing

TABLE 4

CHARACTERISTICS OF EXPERIMENTAL PASTURES[a]

	Fescue-Legume				Fescue			
	Large Cows		Small Cows		Large Cows		Small Cows	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Percent Forage ADL	7.43[b]	1.24	7.76[b]	1.01	7.31[b]	.85	7.03[b]	.52
Percent Forage Digestibility	58.17[c]	.0113[c]	57.88[c]	.0133	55.04[d]	.0106	53.61[e]	.0147

[a]Means were separated by Duncan's New Multiple Range Test Procedures (Snedecor and Cochran, 1967).

[b]Means on a line with different superscripts differ significantly ($P < .05$).

[c,d]Means on a line with different superscripts differ significantly ($P < .02$).

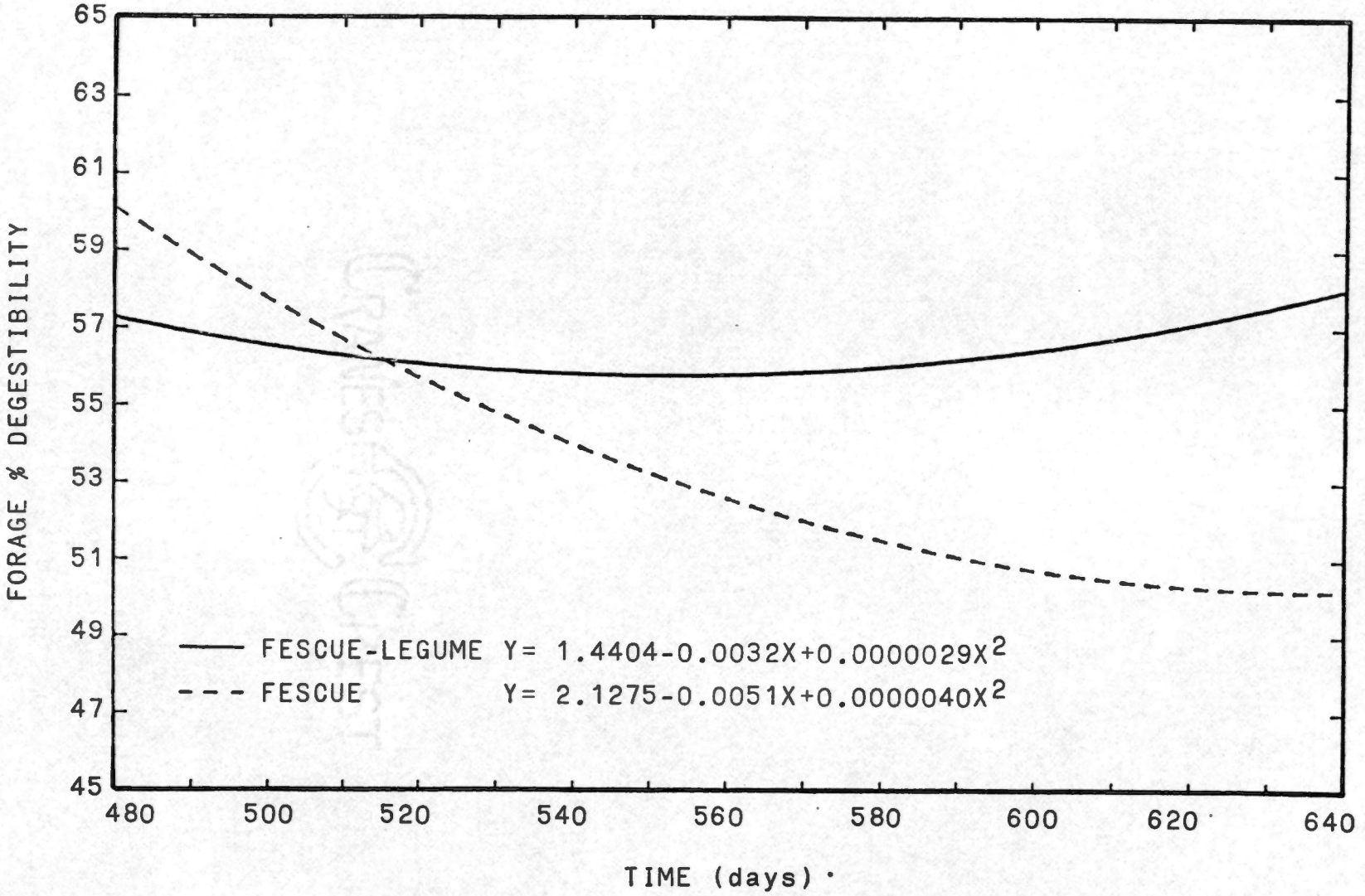


Figure 5. Forage digestibility.

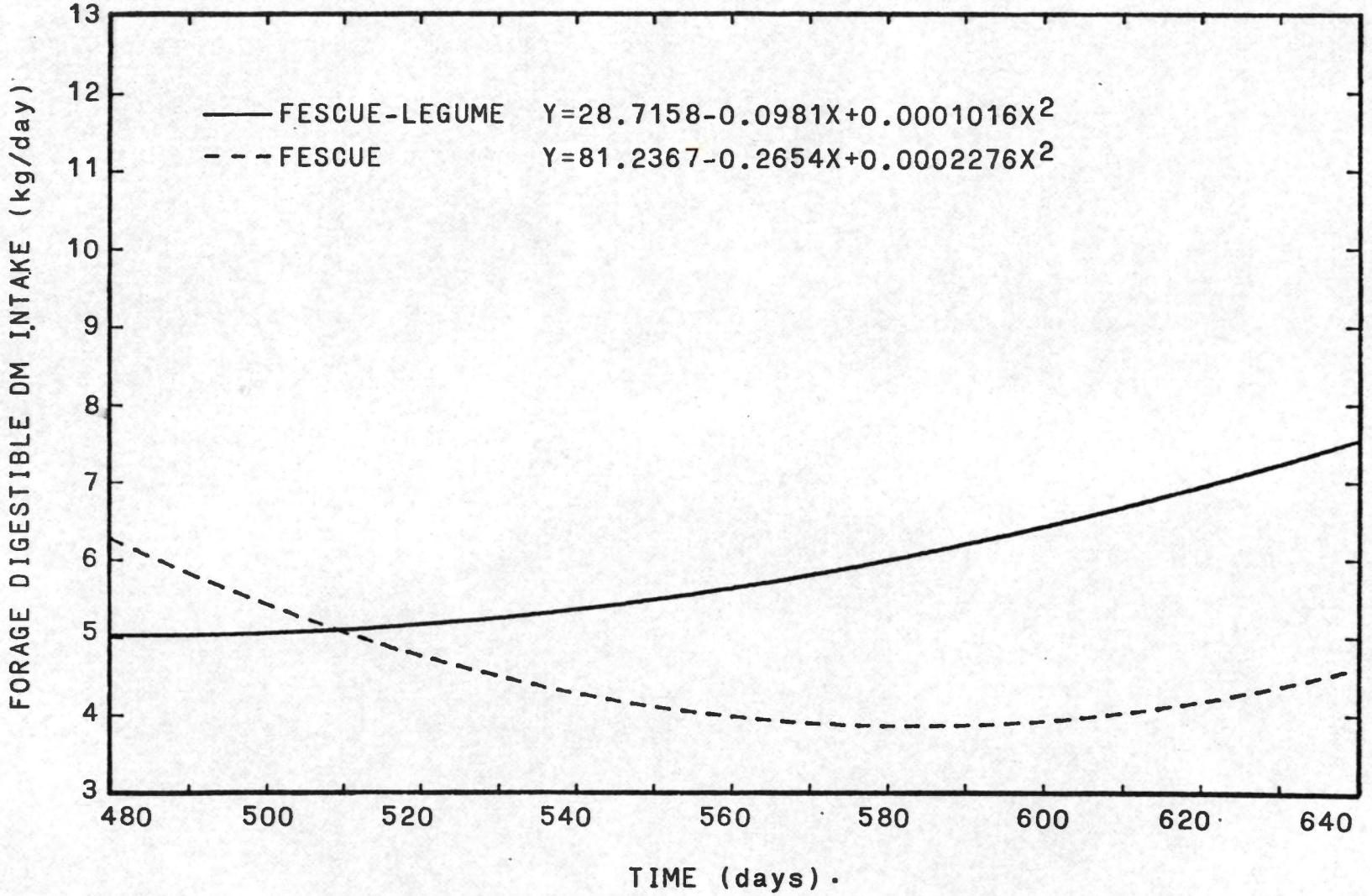


Figure 6. Forage digestible DM intake.

fescue pastures. Barth *et al.* (1972) found similar results with steers grazing fescue-lespedeza pastures from May to September.

Cow Weight and Fat Maintenance

Cows grazing the two pasture qualities maintained similar ($P > .05$) amounts of weight and subcutaneous fat during the grazing season (Table 5), although cows grazing fescue-legume tended to maintain slightly more weight.

Seasonal Cow Weight and Fat Change

Cows grazing fescue-legume pastures used the extra forage consumed to gain 30 kg more ($P < .01$) weight and 2.2 mm more subcutaneous fat than cows grazing fescue pastures (Table 6).

Milk Production and Weaning Weight

Cows grazing fescue-legume and fescue pastures produced similar amounts of milk ($P > .05$, Table 6). Since cows grazing fescue-legume pastures gained ($P < .05$) more weight and more fat than cows grazing fescue pastures, they apparently used the extra nutrients consumed for weight and fat gain and not for increased milk production. Wilson *et al.* (1969) reported that cows fed above and below NRC requirements gain and lose weight, respectively but maintain milk production. The cows on fescue pastures gained small amounts of weight and fat thus using the greater amount of their nutrients consumed for maintenance and milk production. Cows on fescue-legume pastures, however, weaned calves that averaged 15 kg heavier ($P > .07$) than did cows on fescue pastures (Table 6). This

TABLE 5

MEANS AND STANDARD DEVIATIONS BY PASTURE QUALITY OF COW PERFORMANCE CHARACTERISTICS

	Fescue-Legume		Fescue	
	$\bar{X}$	SD	$\bar{X}$	SD
Seasonal Cow Weight (kg)[g]	474.71[b]	46.51	464.24[b]	34.03
Seasonal Cow Fat (mm)	7.35[b]	3.68	7.49[b]	3.68
Seasonal Cow Weight Change (kg)	32.57[c]	18.23	2.94[d]	42.37
Seasonal Cow Fat Change (mm)	4.24[c]	2.48	2.05[d]	2.96
Fall Measurements				
Fall Cow Weight (kg)	465.51[b]	53.50	451.90[b]	38.04
Fall Cow Fat (mm)	8.10[b]	4.77	8.45[b]	5.48
Fall Cow Height (mm)	117.93[b]	4.03	117.18[b]	3.48
Beginning Cow Weight (kg)	462.17[b]	58.65	466.46[b]	36.51
Ending Cow Weight (kg)	494.74[b]	59.26	469.41[b]	38.82
Beginning Cow Fat (mm)	5.39[b]	2.89	6.55[b]	3.36
Ending Cow Fat (mm)	9.63[b]	4.74	8.61[b]	4.44
Milk Production (kg/day)	8.26[b]	1.99	8.82[b]	2.01
Weaning Weight (kg)	245.47[e]	22.51	230.07[f]	28.60

[a]Means were separated by Duncan's New Multiple Range Test Procedure (Snedecor and Cochran, 1967).

[b]Means on a line with different superscripts differ significantly ($P < .05$).

[c,d]Means on a line with different superscripts differ significantly ($P < .01$).

[e,f]Means on a line with different superscripts differ significantly ($P < .07$).

[g]Denotes measurements made during the experimental period.

TABLE 6

MEANS AND STANDARD DEVIATION OF COW CHARACTERISTICS[a]

	Fescue-Legume				Fescue			
	Large Cows		Small Cows		Large Cows		Small Cows	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Seasonal Cow Weight (kg)[h]	510.58[b]	50.25	438.83[c]	42.76	479.93[d]	34.67	448.54[c,d]	26.36
Seasonal Cow Fat (mm)	8.51[b]	3.99	6.19[b]	3.12	7.83[b]	3.35	7.16[b]	4.14
Seasonal Cow Weight Change (kg)[h]	32.72[e]	32.43	14.31[e]	1.61	24.25[f]	24.25	4.28[f]	13.71
Seasonal Cow Fat Change (mm)	4.56[e]	3.02	3.92[e]	1.89	2.80[e,f]	2.59	1.30[f]	2.70
Fall Measurements								
Fall Cow Weight (kg)	490.11[b]	38.15	440.80[c]	57.02	463.81[b,c]	42.54	439.99[c]	30.63
Fall Cow Fat (mm)	8.40[b]	4.45	7.70[b]	5.29	9.50[b]	5.36	7.40[b]	5.68
Fall Cow Height (mm)	120.00[b]	3.05	115.85[c]	3.94	119.35[b]	3.00	115.00[c]	2.30
Beginning Cow Weight (kg)	497.01[b]	52.59	427.24[c]	42.25	482.03[b,d]	40.39	450.87[b,d]	25.39
Ending Cow Weight (kg)	529.02[b]	52.01	459.67[c,d]	44.44	483.64[d]	33.05	455.17[d]	29.53
Beginning Cow Fat (mm)	6.38[b]	2.96	4.39[b]	2.59	6.52[b]	3.03	6.57[b]	3.83
Ending Cow Fat (mm)	10.95[b]	5.37	8.31[b]	3.84	9.32[b]	4.13	7.89[b]	4.85
Milk Production (kg/day)	8.64[b]	2.20	7.87[b]	1.78	8.74[b]	2.08	8.90[b]	1.93
Calf Weaning Weight (kg)	243.17[g]	25.44	247.94	19.58[g]	235.00	29.54[g]	225.17[g]	27.67

[a]Means were separated by Duncan's New Multiple Range Test Procedure (Snedecor and Cochran, 1967).

[b,c,d]Means on a line with different superscripts differ significantly ($P < .05$).

[e,f]Means on a line with different superscripts differ significantly ($P < .01$).

[g]Means on a line with different superscripts differ significantly ($P < .10$).

[h]Denotes measurements made during the experimental period.

increased weaning weight was due to the increased quality of forage available for consumption to the calves on fescue-legume pastures in late summer and early fall. Neville (1962) and Melton *et al.* (1967) reported that milk production was less important for calf gain after 60 days and 90 days of age respectively.

Relationship Between Forage Dry Matter Intake and Cow Characteristics

Cows grazing fescue-legume pastures consumed 2 kg/day more forage DM than the cows grazing fescue pastures. For these cows on fescue-legume pastures seasonal cow weight and seasonal cow weight change accounted for a much larger amount of the variation in forage DM intake than for cows on fescue pastures (r^2 = 57.5 vs 29.4). For fescue-legume pastures, milk production and seasonal cow weight accounted for almost 65% of the variation in forage DM intake. A similar model for cows on fescue pastures explained only 44% of the variation in forage DM intake. It appears that for cows grazing fescue-legume pastures, cow weight, cow weight change and milk production were much more important for explaining variation in forage intake than they were for cows on fescue pastures. Figures 7 and 8 show the relationship between cow weight, milk production and forage DM intake for cows grazing fescue-legume and fescue pastures. These figures indicate that for all but the heaviest cows on fescue-legume pastures that as forage DM intake increases, milk production and cow weight increase. Holmes *et al.* (1961) also reported that variations in the live weight change of mature dry cows on grass-legume pastures accounted for 41% of variation in forage intake.

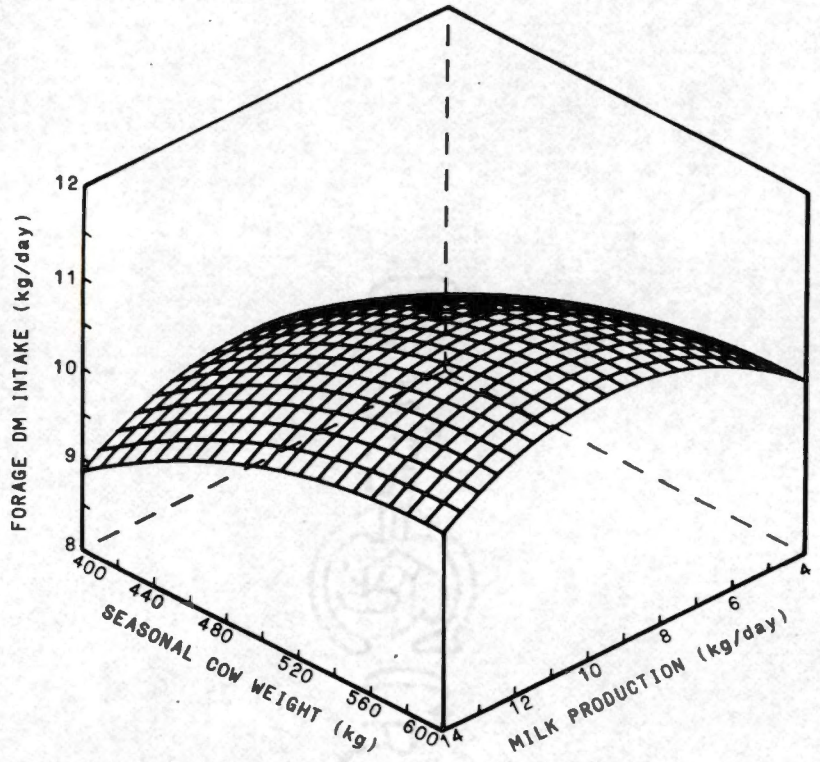


Figure 7. Relationship between forage DM intake and cow characteristics for fescue-legume pastures.

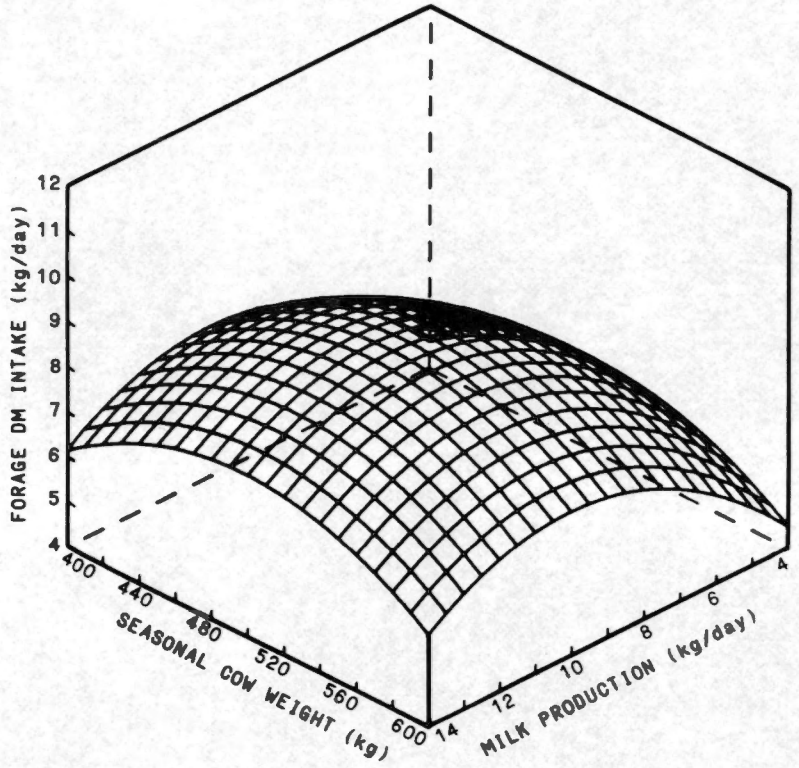


Figure 8. Relationship between DM intake and cow characteristics for fescue pastures.

Relationship Between Forage Digestibility and Cow Characteristics

Cows grazing fescue-legume pastures had higher ($P < .01$) average digestibilities than cows grazing fescue pastures. Figures 9 and 10 show the relationship between percent forage digestibility, milk production and cow weight for cows grazing fescue-legume and fescue pastures, respectively. There is no apparent relationship between percent forage digestibility, milk production and cow weight for pasture quality ($R^2 = .12$ and .16) for cows grazing fescue-legume and fescue pastures, respectively. A model including the affects of cow weight and cow weight change also did not explain much of the variation in digestibility of forage for fescue-legume pastures ($R^2 = .11$), although for fescue pastures this model accounted for 37% of the variation in percent forage digestibility. The regression of milk production on percent forage digestibility accounted for less than 5% of the variation in digestibility for fescue-legume and fescue pastures, respectively. Percent forage digestibility for fescue pastures, regressing cow weight on digestibility, showed that 27% of variation in digestibility could be accounted for. Whereas, for cows grazing fescue-legume pastures cow weight accounted for only 6.5% of the variation in forage digestibility. Gill (1975) reported that digestibility was not correlated with cow weight or fat thickness, but there was a tendency for a positive relation with cow height and average daily gain for Angus cows fed timothy, orchard-grass silage and alfalfa pellets. He also found crude protein digestibility highly correlated ($P < .01$) to cow weight.

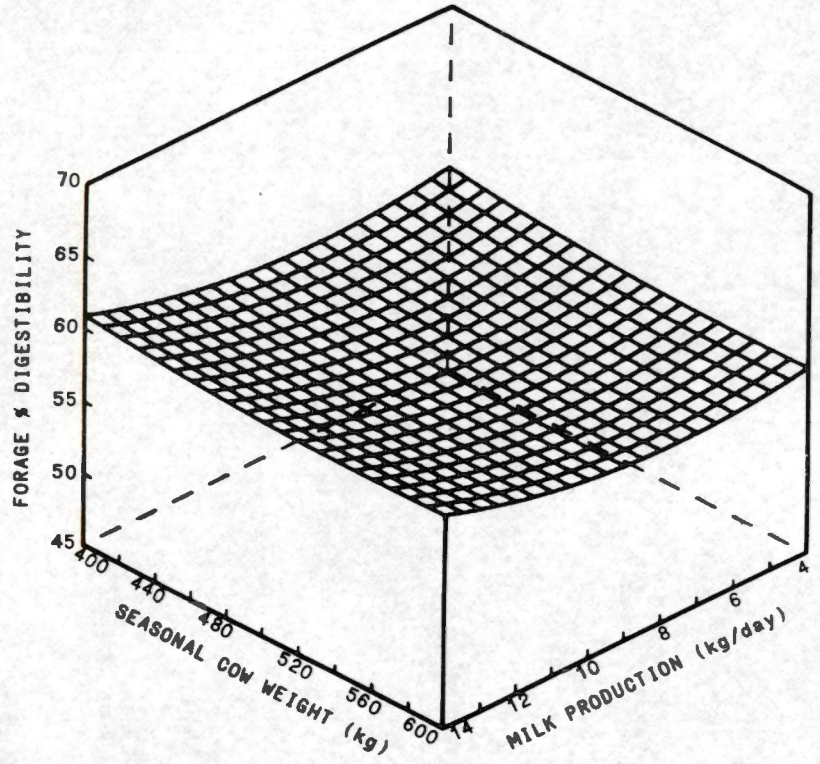


Figure 9. Relationship between % forage digestibility and cow characteristics for fescue-legume pastures.

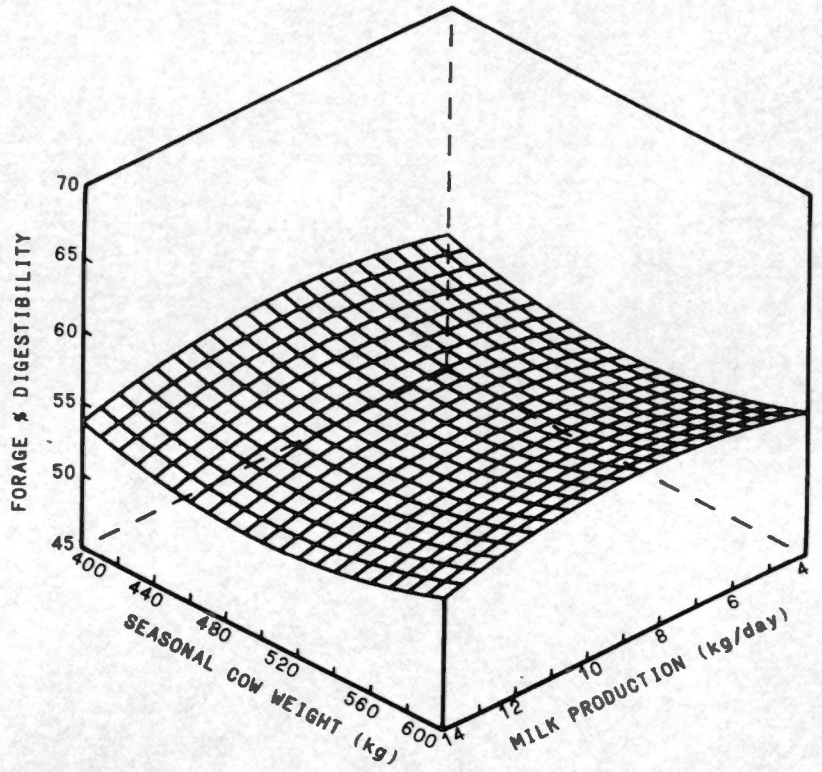


Figure 10. Relationship between % forage digestibility and cow characteristics for fescue pastures.

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APPENDIX

TABLE A-1

PERCENT ADL IN AVAILABLE FORAGE

Pasture	b_0	b_1	b_2
1[a]	-18.57898154	0.08046292	-0.00006023
2[b]	-87.84892248	0.33854393	-0.00029758
3[c]	-6.34641078	0.04419384	-0.00003599
4[d]	-6.80904703	0.03856252	-0.00002357

[a]Fescue-legume, large cows.

[b]Fescue-legume, small cows.

[c]Fescue, small cows.

[d]Fescue, large cows.

TABLE A-2

PERCENT ADL IN FECAL DRY MATTER

Cow No.	Pasture	b_0	b_1	b_2
25	2[b]	-92.99575930	0.37480720	-0.00031360
28	2	-35.24867410	0.14724390	-0.00010876
35	4[d]	-3.34007453	0.06109070	-0.00005061
40	1[a]	-161.81463895	0.62367345	-0.00053737
48	3[c]	56.63277138	-0.13369926	0.00010738
70	3	38.94563519	-0.07004498	0.00004761
85	2	-111.85871907	-.45350464	-0.00039486
140	4	87.23123962	-0.25562075	0.00022812
180	1	-24.35037628	0.12832773	-0.00009622
201	3	60.18231926	-0.15791002	0.00013838
206	1	-5.28478703	0.05264536	-0.00001868
305	3	-7.30609731	0.10651109	-0.00011604
335	1	-102.50612727	0.41306054	-0.00035434
386	1	-38.73096065	0.18251831	-0.00014426
415	3	126.66253791	-0.39041725	0.00034038
429	2	4.68224213	0.01827141	0.00001042
445	2	-78.98388047	0.33267137	-0.00028248
448	4	123.34988884	-0.39104514	0.00035178
577	4	60.01810358	-0.14972500	0.00012677
758	3	101.63371881	-0.30310326	0.00026376
836	4	97.80273549	-0.29602994	0.00026255
845	4	-32.41233811	0.16049616	-0.00013435
890	4	11.01916109	0.02433688	-0.00002758
1040	4	-86.96262580	0.36404311	-0.00032154
1127	4	-36.34759290	0.17876223	-0.00015107
1286	1	-134.59204396	0.51454723	-0.00043022
1337	1	-40.72353868	0.17897711	-0.00013420

TABLE A-2 (continued)

Cow No.	Pasture	b_0	b_1	b_2
1436	2	-95.90416361	0.41145630	-0.00036467
1516	1	-49.27269466	0.20238733	-0.00014883
1561	2	-43.02890282	0.16063244	-0.00009268
1659	4	17.51732497	-0.00049841	-0.00000513
1661	3	51.99435058	-0.12080019	0.00009796
1668	1	-161.13896007	0.62005560	-0.00053510
1701	3	12.72884925	0.00727379	-0.00000383
1989	3	150.28930243	-0.47670393	0.00042042
2477	2	-46.34277879	0.22006407	-0.00018720
2497	1	-206.16555193	0.77537110	-0.00066874
3100	2	-116.84045891	0.45569209	-0.00037889
5106	2	-84.30367837	0.34352329	-0.00028435
9630	3	30.17889269	-0.04740835	0.00003630

[a]Fescue-legume, large cows.

[b]Fescue-legume, small cows.

[c]Fescue, small cows.

[d]Fescue, large cows.

TABLE A-3

PERCENT CR_2O_3 IN FECAL DRY MATTER

Cow No.	Pasture	b_0	b_1	b_2
25	2[b]	-8.30469721	0.06237842	-0.00006742
28	2	0.14522449	0.03003480	-0.00003838
35	4[d]	-34.10423123	0.14024934	-0.00012613
40	1[a]	25.93815619	-0.06559050	0.00004808
48	3[c]	-8.45346770	0.05266633	-0.00004828
70	3	-10.50193007	0.06188113	-0.00006172
85	2	4.49619439	0.00804240	-0.00001519
140	4	-77.72350062	0.29867350	-0.00026672
180	1	20.00653684	-0.05237901	0.00004295
201	3	-41.65270143	0.17069984	-0.00015449
206	1	8.30384000	-0.00354858	-0.00000519
305	3	-68.99402567	0.27782871	-0.00025369
335	1	18.32942350	-0.04191728	0.00002962
386	1	2.39004745	0.02587275	-0.00003725
415	3	-8.78008183	0.05406792	-0.00005008
429	2	47.35017839	-0.14296696	0.00011819
445	2	28.28479552	-0.07584880	0.00005933
448	4	-69.98452669	0.27064486	-0.00024372
577	4	-66.23882681	0.25451748	-0.00022497
758	3	-27.19611831	0.11843368	-0.00010890
836	4	-21.30059452	0.10056642	-0.00009374
845	4	-78.38338444	0.29795182	-0.00026267
890	4	-46.88668335	0.18743935	-0.00016817
1040	4	-74.56731941	0.28493965	-0.00025150
1127	4	-62.97188800	0.23796467	-0.00020914
1286	1	9.98113957	-0.00627905	-0.00000586
1337	1	42.59980474	-0.12819132	0.00010603

TABLE A-3 (continued)

Cow No.	Pasture	b_0	b_1	b_2
1436	2	34.47008509	-0.09268170	0.00007081
1516	1	3.50538664	0.01199132	-0.00001871
1561	2	17.94895425	-0.04065262	0.00002903
1659	4	-40.28370815	0.16479932	-0.00014883
1661	3	11.77711563	-0.02185702	0.00001598
1668	1	10.96424352	-0.01343234	0.00000257
1701	3	-46.81717299	0.19161029	-0.00017574
1989	3	-23.16999838	0.10125194	-0.00008838
2477	2	-31.82678557	0.14580918	-0.00014160
2497	1	4.02726312	0.01566170	-0.00002558
3100	2	-17.98023900	0.09245403	-0.00009169
5106	2	30.31460027	-0.08515018	0.00006884
9630	3	-73.15106305	0.27884358	-0.00024718

[a]Fescue-legume, large cows.

[b]Fescue-legume, small cows.

[c]Fescue, small cows.

[d]Fescue, large cows.

TABLE A-4

PERCENT DIGESTIBILITY EQUATIONS

Cow No.	Pasture	b_0	b_1	b_2
25	2[b]	3.07193422	-0.00925014	0.00000850
28	2	4.15289572	-0.01332111	0.00001233
35	4[d]	0.91604090	-0.00076169	0.00000009
40	1[a]	-2.08912459	0.00984258	-0.00000897
48	3[c]	2.39046833	-0.00596379	0.00000478
70	3	1.91868927	-0.00419470	0.00000305
85	2	2.71856015	-0.00772729	0.00000688
140	4	3.37447361	-0.00940073	0.00000744
180	1	1.11807165	-0.00171422	0.00000132
201	3	2.66912910	-0.00727360	0.00000620
206	1	1.48169118	-0.00315512	0.00000281
305	3	0.29824582	0.00186335	-0.00000248
335	1	-0.88078606	0.00556287	-0.00000527
386	1	0.81479709	-0.00055372	0.00000028
415	3	4.48758100	-0.01364355	0.00001174
429	2	5.19461376	-0.01697125	0.00001549
445	2	3.48368981	-0.01052498	0.00000947
448	4	4.69886142	-0.01429628	0.00001217
577	4	2.47919062	-0.00596735	0.00000449
758	3	3.91418501	-0.01163891	0.00000998
836	4	4.07897030	-0.01194840	0.00000992
845	4	0.03368492	0.00224490	-0.00000243
890	4	1.15581618	-0.00123623	0.00000027
1040	4	-1.66162837	0.00857181	-0.00000825
1127	4	0.04101386	0.00232875	-0.00000251
1286	1	-1.57569092	0.00771949	-0.00000684
1337	1	0.63836249	-0.00019883	0.00000015

TABLE A-4 (continued)

Cow No.	Pasture	b_0	b_1	b_2
1436	2	3.12700408	-0.00884546	0.00000771
1516	1	0.30036698	0.00082263	-0.00000060
1561	2	3.27742824	-0.01086093	0.00001066
1659	4	1.36347538	-0.00200393	0.00000095
1661	3	2.36677943	-0.00596117	0.00000482
1668	1	-2.33270991	0.01067922	-0.00000973
1701	3	1.32570868	-0.00259475	0.00000217
1989	3	4.89361331	-0.01516044	0.00001320
2477	2	4.30709042	-0.01337898	0.00001190
2497	1	-3.70032412	0.01540213	-0.00001380
3100	2	2.44427950	-0.00706842	0.00000667
5106	2	3.25662596	-0.00989411	0.00000908
9630	3	1.80548167	-0.00407743	0.00000324

[a]Fescue legume, large cows.

[b]Fescue-legume, small cows.

[c]Fescue, small cows.

[d]Fescue, large cows.

TABLE A-5

FORAGE DRY MATTER INTAKE EQUATIONS

Cow No.	Pasture	b_0	b_1	b_2
25	2[b]	107.27473202	-0.38349644	0.00036752
28	2	147.85547877	-0.53746977	0.00051604
35	4[d]	93.23892778	-0.29407349	0.00025354
40	1[a]	-91.85190740	0.34604485	-0.00028894
48	3[c]	60.92567632	-0.18317952	0.00015563
70	3	71.27883823	-0.22888726	0.00019910
85	2	78.25665199	-0.26668709	0.00025840
140	4	197.94968215	-0.66784939	0.00058341
180	1	-12.94829402	0.07986969	-0.00006715
201	3	126.24522876	-0.42176198	0.00037453
206	1	38.30723373	-0.12171041	0.00012713
305	3	89.60427397	-0.29074933	0.00025316
335	1	-49.88468483	0.20388444	-0.00017013
386	1	45.61552475	-0.15516041	0.00016025
415	3	96.42206425	-0.31343493	0.00027444
429	2	53.63615591	-0.18963637	0.00019832
445	2	42.33850043	-0.13932816	0.00014500
448	4	245.80059890	-0.84249754	0.00074427
577	4	174.30713393	-0.57335564	0.00049114
758	3	138.93834179	-0.46507633	0.00041296
836	4	104.18136779	-0.34076531	0.00029769
845	4	117.50342110	-0.38310048	0.00033040
890	4	121.00601339	-0.38735052	0.00033088
1040	4	87.65012949	-0.27313813	0.00023017
1127	4	115.72593533	-0.37012930	0.00031636
1286	1	-28.08202365	0.10764090	-0.00006974
1337	1	-68.49177749	0.26286226	-0.00021566

TABLE A-5 (continued)

Cow No.	Pasture	b_0	b_1	b_2
1436	2	32.61939350	-0.10329057	0.00011151
1516	1	223.61971726	-0.07350354	0.00008856
1561	2	93.54415723	-0.34647989	0.00035101
1659	4	110.75123796	-0.35340625	0.00030271
1661	3	35.45613045	-0.09042939	0.00007729
1668	1	-60.80778999	0.23599037	-0.00019232
1701	3	119.75361923	-0.40627787	0.00036881
1989	3	132.87134880	-0.43813042	0.00038138
2477	2	177.69874552	-0.63126413	0.00058505
2497	1	-58.71434836	0.22031869	-0.00017482
3100	2	131.420883313	-0.47044349	0.00044935
5106	2	32.78943392	-0.10694486	0.00011940
9630	3	173.82879212	-0.58147291	0.00050771

[a]Fescue-legume, large cows.

[b]Fescue-legume, small cows.

[c]Fescue, small cows.

[d]Fescue, large cows.

TABLE A-6

FORAGE DIGESTIBLE DRY MATTER INTAKE

Cow No.	Pasture	b_0	b_1	b_2
25	2[b]	86.51107595	-0.31245419	0.00029584
28	2	130.16526722	-0.47708167	0.00045234
35	4[d]	53.75005715	-0.16591282	0.00013822
40	1[a]	-83.90493707	0.31338079	-0.00027010
48	3[c]	49.46716695	-0.15294274	0.00012790
70	3	50.13582156	-0.15590542	0.00013251
85	2	67.15796111	-0.23317693	0.00021966
140	4	136.41466497	-0.45950390	0.00039718
180	1	-2.01741451	0.02889639	-0.00002560
201	3	88.03560528	-0.29579584	0.00026043
206	1	32.12222682	-0.10582907	0.00010557
305	3	50.06907110	-0.15593479	0.00012992
335	1	-45.02211693	0.17950222	-0.00015672
386	1	27.22604559	-0.09040451	0.00009161
415	3	84.36522770	-0.28086909	0.00024428
429	2	82.27955686	-0.29839209	0.00028728
445	2	55.01629572	-0.19145876	0.00018394
448	4	171.66342061	-0.58828933	0.00051506
577	4	119.91732590	-0.39277891	0.00033162
758	3	106.80695511	-0.35967197	0.00031600
836	4	82.21583850	-0.27137379	0.00023305
845	4	59.79693866	-0.19066059	0.00016089
890	4	76.42435185	-0.23999231	0.00019860
1040	4	33.67370103	-0.09355764	0.00007178
1127	4	62.09436705	-0.19357211	0.00016133
1286	1	-37.94751221	0.14001917	-0.00010920
1337	1	-38.92767160	0.14960036	-0.00012290

TABLE A-6 (continued)

Cow No.	Pasture	b_0	b_1	b_2
1436	2	43.90691325	-0.14744630	0.00014167
1516	1	11.96214348	-0.03805642	0.00004853
1561	2	98.31020126	-0.37119025	0.00036580
1659	4	70.83651560	-0.22198684	0.00018386
1661	3	36.89366260	-0.10692031	0.00008884
1668	1	-67.05573472	0.25363270	-0.00021816
1701	3	73.31859820	-0.24858737	0.00022407
1989	3	111.91998955	-0.37637465	0.00032750
2477	2	136.37781646	-0.48588831	0.00044609
2497	1	-73.87322492	0.27178486	-0.00023106
3100	2	101.74458848	-0.36902496	0.00035089
5106	2	50.28513579	-0.17769515	0.00017557
9630	3	107.23447418	-0.35761134	0.00030934

[a]Fescue-legume, large cows.

[b]Fescue-legume, small cows.

[c]Fescue, small cows.

[d]Fescue, large cows.

VITA

Johnny Dale Beaty, son of John C. and Ninis Beaty, was born in Detroit, Michigan on August 9, 1953. He grew up and attended elementary and secondary schools in Celina, Tennessee. He entered The University of Tennessee, Knoxville in September 1971 and received the Bachelor of Science degree in Animal Science in June 1976. He served in the United States Army from January 1973 to January 1975. He entered graduate school at The University of Tennessee, Knoxville in September 1976 to study ruminant nutrition and beef production and was granted the Master of Science degree in Animal Science in December 1977.