THE GRAZING HABITS OF CATTLE ON PASTURE

by

Alan Jonathan Sheppard

Thesis submitted to the Graduate Faculty of the

Virginia Polytechnic Institute

in candidacy for the degree of

MASTER OF SCIENCE

in

Agronomy

APPROVED:

Director of Graduate Studies

Dean of Agriculture

APPROVED:

Head of Department

Supervisor or Major Professor

August, 1954

Blacksburg, Virginia

TABLE OF CONTENTS

Tables

TABLE OF CONTENTS

Tables (Continued)

Graphs

TABLE OF CONTENTS

Graphs (Continued)

TABLE OF CONTENTS

Graphs (Continued) Page

* * * * *

ACKNOWLEDGEMENTS

The writer wishes to express sincere appreciation to Dr. R. E. Blaser, Agronomist, Virginia Polytechnic Institute for his interest, guidance, and for acting as Chairman of the advisory committee.

Grateful acknowledgement is made to the other members of the advisory committee: Dr. C. M. Kincaid, Dr. J. D. Pendleton, and Mr. Clyde Kramer who have read and criticized the first draft of this manuscript.

Appreciation is expressed to Dr. R. K. Stivers and Mr. H. E. Dailey for their time and advice on general techniques of writing and presenting data.

Gratitude is particularly extended to the staff of the Northern Virginia Pasture Research Station, and also to Dr. H. L. Dunton, Head of the Agronomy Department, and to other members of the department.

INTRODUCTION

The growing importance of grassland and all its products is becoming more evident. A grassland economy is the backbone of the sheep, dairy cattle, and beef cattle industries. Grassland farming makes for a more permanent type of agriculture. An increased acreage in sod crops results in less erosion, better soil structure and drainage, and higher organic matter. Soil productivity can be maintained or improved under grassland farming practices.

A general appreciation of the value of pasture as a source of livestock feed, improvements in strains of grasses and legumes, and better knowledge of fertilizer usage have encouraged the increase in acreage of highly productive pastures. Well managed pastures are highly productive and supply nutritious herbage high in minerals and protein.

The Northern Virginia Pasture Research Station at Middleburg, Virginia has experiments under way to measure quantity of production and the nutritional value of pasture herbage when grazed by dairy and beef cattle (1 and 2). These experiments are designed to measure the value of species, mixtures, methods of rotational grazing, and continuous grazing of one mixture as compared with grazing different mixtures in a rotational sequence. Data are being obtained on carrying capacity, livestock gains, carcass characteristics, palatability, and rate of milk production.

This study was undertaken to gain supplementary information on the established grazing experiments at Middleburg. It was postulated that data on animal behavior would help interpret the animal responses observed. This report gives data on animal grazing frequency; however, data on other aspects of animal behavior were obtained.

REVIEW OF LITERATURE

Grazing habits of cattle are influenced by supplemental feeds, rotational grazing, amount of forage herbage available, succulence of herbage, climate, season, and by darkness. The discrepancies reported in literature may be associated with differences in environments, plant species, animals, management practices, and experimental designs and procedures.

One of the first recorded studies of animal behavior was reported by Shepperd (15) in 1927. Three Hereford steers were observed every 15 minutes for a 24 hour period. The steers grazed 8-1/4 hours per 24-hour day on a sweet clover pasture. The main grazing activity occurred during the periods 7:00 to 10:00 P. M., and 5:00 to 10:00 A. M. The steers were lying down during the period 10:00 P. M., to 5:00 A. M. A similar time schedule was observed for these steers when grazing sudan grass. The results agreed with those for sweet clover. Cory (5) obtained detailed data for behavior of cattle under range conditions in Texas. During a period of three years, 461 minutes daily (i.e., from getting up in the morning to bedding down at night) were spent grazing.

Moseley, Stewart, and Graves (14) studied three pasture mixtures grazed by Holstein-Friesian cows during two days in June and one day in August. They reported no grazing at 4:00 A. M., when the cows were removed from the pastures for the morning milking; however, observations were not made between 9:00 P. M., and 4:00 A. M. Cows on pasture alone

grazed an average of 9.16 hours per day and cows on pasture supplemented with alfalfa hay grazed 29 percent less. When cows on pasture were given one pound of grain per six pounds of milk produced, they grazed 39 percent less time, than cows on pasture alone. Cows on pasture with grain ration of one pound of grain to each three pounds of milk grazed 42 percent less time than those on pasture alone. These observations indicate that the rate of supplemental feeding is associated with grazing periods.

Gibbel and Lindbom (8) found that the intensity of grazing at night is as great as during the day, and the grazing periods alternate fairly regularly with rest periods. Hodgson (11) compared the length and number of times spent grazing under a continuous grazing system with a like area of land divided into six pastures. Four cows were used on each of the two treatments. Cows on rotational pasture grazed about 28.02 minutes less time and spent 38.38 minutes more time lying down than similar cows on continuous pasture. Cows on rotational pasture grazed 8.33 times and laid down 3.13 times, as compared with 7.87 times and 2.38 times, respectively, for cows on continuously grazed lots. As grazing progressed, the cows on rotational pasture expended less time grazing and more time in lying down. The reverse was true on a continuously grazed pasture.

In 1931 and 1932 at Beltsville, Maryland, records were taken every 15 minutes for three 24-hour periods by Hein (10). The animals used were long yearling and short two-year old steers in a gaining condition.

The amount of feed present affected the total time spent grazing during a 24-hour period. Approximately 8-3/4 hours were spent grazing pastures with abundant herbage, as compared to 10 hours per day on pastures with less herbage. About 66 percent of the grazing occurred during the daylight period from 6:00 A. M., to 6:00 P. M.

In New Zealand, Bruce-Levy (3) studied the habits of dairy cattle to obtain information on the reason for differences in the flavor between night and morning milk. Comparatively little grazing was done between midnight and milking time in the morning. It was suggested that this may have an important significance when coupled with the mild feed-flavor of the morning cream as compared with the strong feed-flavor of the night cream. It was discovered that if the cows did not eat flavor influencing herbage 4 to 5 hours prior to milking, the milk had little or no feed flavor. The suggestion was made that flavor influencing herbage might be used in the evenings since cows graze very little at night.

Hein (9) in 1937 at Beltsville, Maryland, reported that no significant differences were observed in the gains made by steers, at the rate of one head per acre, on pastures grazed heavily and alternately, and on pastures grazed heavily and continuously.

Kennedy (13) reported in 1941 that about 8 hours of the day is spent grazing with the time equally divided between night and day. Cows on the test walked 2.55 miles during 24 hours, 2.01 miles of which were covered during daylight hours. Rapidly growing, tender herbage not over 4 to 6 inches in height was preferred by the cows.

Johnstone-Wallace and Kennedy (12) studied the grazing habits of Aberdeen-Angus and Hereford beef cows on pasture without supplementary feed over certain continuous periods of 24 hours during the months of July, August, and September. The cows spent from 7 to 8 hours grazing regardless of the herbage length. About 5 hours of the 7 to 8 hours could be regarded as employed in gathering herbage and the balance of the time was spent in walking short distances and in selecting the area to be grazed. Approximately 60 percent of the grazing was performed by day. The cows traveled about 2-1/2 miles during the 24 hours, 2 miles of which were by day.

The behavior of dairy cattle under normal commercial conditions of management was studied in two series of observations by Castle, Foot, and Halley (4) at the University of Reading. Four cows were observed continuously for 24 hours on four occasions at approximately two-week intervals and a herd (average of 52 cows) was observed continuously for 24 hours on twelve occasions at approximately one month intervals. These workers found that animals grazed for a shorter time, walked less, and took fewer drinks on "good" pastures as compared to "poor" pastures. Major peaks of grazing were noted after each milking followed by periods of lying down, especially during the night. Cows on sparse herbage walked greater distances in 24 hours than those on the more lush pastures. No aspect of the grazing behavior was found to be strongly related to either current milk production or air temperature. The time when grazing ceased and the herd bedded down was

related to the time of sunset. The cows grazed 6.52 hours and walked an average of 1.74 miles per 24 hours, exeluding trips to the cowshed.

In 1951, Waite (16) reported on two groups of Ayrshire dairy cows observed for twenty-two 24-hour periods during the months of May to September. The cows received no supplement at any time. One group of cows grazed under a system close-folding (grazing one day in a pasture) and the other in small rotational paddocks. Close-folding increased the grazing time and decreased the weight of herbage eaten, but the differences between the two systems of management were small. The pattern of behavior was very consistent over the 24-hour period with both groups. The longest grazing period followed immediately after the evening milking. The amount of grazing during the hours of darkness was found to be small at all times of the year, but tended to increase as the nights became longer. The cessation of evening grazing was closely linked with the fall of darkness. The activity during the days was fairly regular with three main periods of grazing, one of which occurred immediately after the morning milking; it being separated from the other grazing periods by two main periods of rest. Cows in various stages of lactation grazed for similar times when observed in 1949 and 1950. The grazing time required by cows on rotational pasture increased as the pasture was defoliated.

Fisher (7) studied the grazing habits and related activities of lactating Holstein cows during two observation periods of 240 consecutive hours each. One of the 10-day periods was made in July and the

other in September regardless of weather conditions during the test periods. On the average, cows grazed 9 hours and 2 minutes; loafed 5 hours and 58 minutes; were lying down 9 hours and stood up for 15 hours per day. A uniform grazing pattern of four major grazing periods daily was reported throughout the observations. The grazing periods following morning and evening milkings were the longest and most intense. Selective grazing was high when cows were first turned on a new pasture. High temperatures depressed the overall grazing time of cows and markedly changed the day-night ratio. Grazing time was decreased by a large quantity of forage of low quality. The cows grazed more during daylight than during the hours of darkness. The grazing time of cows was decreased by 7.75 percent when the pasture herbage was supplemented with one pound of grain to every six pounds of milk produced.

GENERAL PROCEDURE

The procedure given here was generally employed in all experiments discussed in this manuscript. Any variance from this general procedure will be reported with the individual experiment.

Data were taken for the animal activity (lying down, standing, walking, and grazing) and the field location (shade, near water, and out in the open). In this report only the grazing activity is discussed. Pasture and weather conditions were recorded for each day of observation.

The period from 10:00 P. M., to 2:00 A. M., was not observed, as it was assumed that the cows were bedded down. Observations were made during a 20-hour day at selected time intervals. The observations made at 1/2 hour intervals were made during the periods of greatest animal activity so that when the grazing stopped, the break in grazing would be more accurately recorded. This interval was widened for what was considered the "less critical" or resting periods. The times of observation were as follows:

A. M. - 2:00, 4:00, 4:30, 5:00, 5:30, 6:00, 7:00, 7:30, 8:00, 8:30, 9:00, 10:00, and 11:00.

P. M. - 1:00, 2:00, 3:00, 4:00, 4:30, 5:00, 5:30, 6:30, 7:00, 7:30, 8:00, 8:30, 9:00, 10:00.

In presenting the data for beef cattle grazing and for the sequence experiments (Tables 4 and 16), the day was broken down into eleven 2-hour periods to simplify calculations. The time zones were based upon the assumption that the data not having been taken continuously,

would not be sensitive enough to warrant calculating on the basis of each individual observation. However, more frequent observations were taken when observing dairy cows and the individual observations were used for calculating the grazing data for the dairy experiment.

The figures used in the calculations were the percent of the animals grazing at any given observation time. For example; if 4 animals were in a lot at 10:00 A. M., and 3 of them were grazing, the value for 10:00 A. M., was 75 percent. The observations that fell within a 2-hour zone were added together and divided by the number of observations, to give apparent grazing percent. The assumption that the percent grazing at a given observation time was constant for a given period is subject to error since this obviously did not always occur. For this reason the terminology; percent, hours, or time of grazing as used in this manuscript are really apparent values. It should also be stressed that the hours grazing per day are based on observations made during 20 hours with the assumption that the cattle did not graze during the 4 unobserved hours at night. The grazing percent of the 20-hour day was used to calculate the hours of grazing per 24-hour day, hence the value expressed as hours will tend to be larger than the actual hours spent in grazing.

The animals were observed by walking near or through the various lots, but care was taken not to unduly disturb the animals. A high powered flashlight was used at night and binoculars during the day whenever the terrain permitted. The same observer took all data for the duration of the experiments.

EXPERIMENT I - BEEF CATTLE GRAZING EXPERIMENT

Procedure

A field experiment was established in August, 1949, to obtain data on the comparative production and quality of herbage from tall and low growing mixtures and/or species. The following six mixtures were used:

Treatment	Mixture
a	Orchardgrass
b	Kentucky 31 fescue
c	Orchardgrass-ladino clover
d	Kentucky 31 fescue-ladino clover
e	Kentucky bluegrass-Virginia white clover
f	Orchardgrass-redtop-Korean lespedeza

A 36 acre land area was divided into 18 lots of two acres each in such a manner as to give the least possible soil variation between the six lots within each of three replicated blocks. The six treatments were assigned at random to the six lots within a replication. Each lot was subdivided into three sub-lots and grazed rotationally in replications I and II. Water was available in each of the sub-lots from a small stream running through the experiment and shade was not equally available in all lots.

The number of heifers or steers used as the grazing animals ranged from 1 to 5 depending upon the availability of herbage. During the

course of the experiment from its origin through the spring of 1953, it became apparent that a better knowledge of animal behavior might help interpret the grazing data. Animal behavior data were recorded for 15 different days for replications I and II, during June, July, and August, 1953 (Table 2). A statistical analysis was made of the data using a split-split plot design (Table 1).

Results and Discussion

When all observations were averaged, the grazing time for the six mixtures tested did not differ (Tables 1 and 2)*. The grazing time ranged from 6.7 hours for orchardgrass-redtop-Korean lespedeza mixture to 7.9 hours for orchardgrass-ladino clover mixture. Table 2 gives a summary of the estimated grazing time for the various mixtures.

During the 15 days observed, the time cattle spent grazing per day ranged from 25.0 to 37.4 percent (Table 2). The differences among days in this experiment could not be associated either with maximum or minimum daily temperatures (Graph 1). The temperature data used for comparison were for the weather station at Lincoln, Virginia. The intensity of grazing was often contrary to an expected decrease of grazing during hot days. The grazing activity was low during July 8 and 9, days of medium to low maximum and minimum daily temperatures, and during

---

* All references to differences are based on statistical significance.

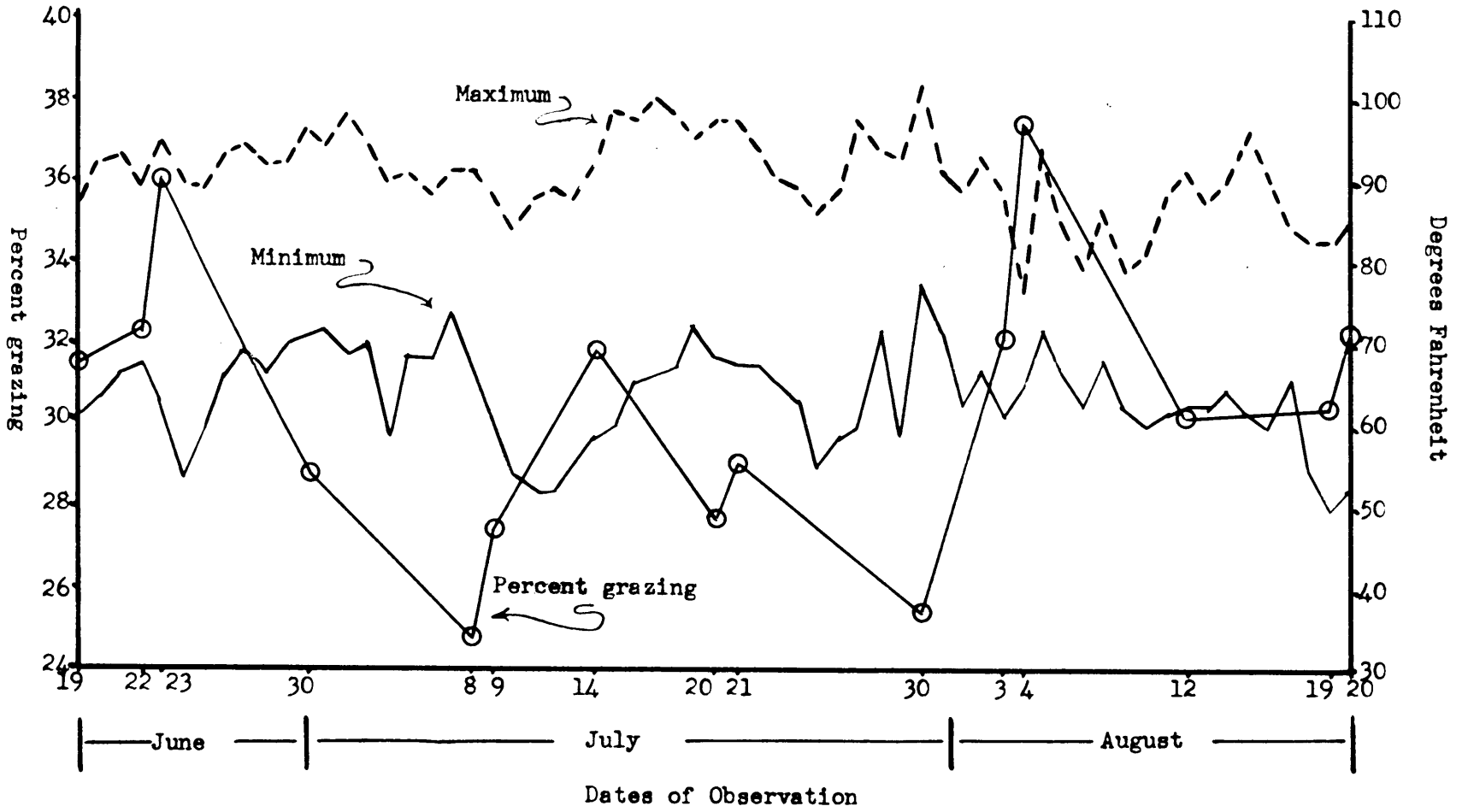
Table 1. Analysis of variance for beef grazing experiment.

Source	D/F	MS	F
Replications	1	2.8000	0.000747
Mixtures	5	1801.8920	4.807994
Error a	5	374.7700	
Days	14	1652.9029	3.168538**
Days X Mixtures	70	496.6590	0.952072
Error b	84	521.6610	
Time	10	96941.8200	192.345988**
Time X Mixtures	50	649.8890	1.289470
Time X Days	140	1655.6186	3.284976**
Time X Days X Mixtures	700	507.4370	1.006825
Error c	900	503.9971	
Total	1979		

** 1 percent level of significance.

Table 2. Estimated grazing time of beef cattle as related to mixtures on different days and their interaction.

Mixtures	Dates of observation														Percent grazing	Hours per day
	19 June	22 June	23 June	30 June	8 July	9 July	14 July	20 July	21 July	30 July	3 August	4 August	12 August	19 August	20 August		
Bluegrass-Virginia white clover	36.4	27.9	35.8	26.3	22.3	27.5	30.9	24.2	25.2	28.8	29.0	37.7	26.5	31.3	27.8	29.2	7.0
Orchardgrass	28.3	32.4	42.1	37.1	25.2	27.3	33.2	29.0	32.6	24.2	40.2	39.0	33.5	25.9	33.7	32.3	7.7
Kentucky 31 fescue	29.4	40.8	39.8	28.9	31.0	32.8	33.6	33.3	30.5	30.7	33.1	33.5	30.3	35.7	25.7	32.6	7.8
Orchardgrass-ladino clover	34.5	36.0	31.8	31.0	18.2	22.6	35.3	32.2	23.7	29.0	28.3	42.6	36.7	42.8	50.0	33.0	7.9
Kentucky 31 fescue-ladino clover	30.9	31.4	33.2	23.4	23.5	29.4	29.2	26.3	36.0	15.5	28.8	36.6	24.1	28.2	29.9	28.4	6.8
Orchardgrass-red top-Korean lespedeza	29.2	26.1	36.7	26.5	29.6	24.1	29.0	21.6	26.7	24.1	33.0	35.2	29.9	19.3	25.4	27.7	6.7
Average	31.5	32.4	36.6	28.9	25.0	27.3	31.9	27.8	29.1	25.4	32.1	37.4	30.2	30.5	32.1		

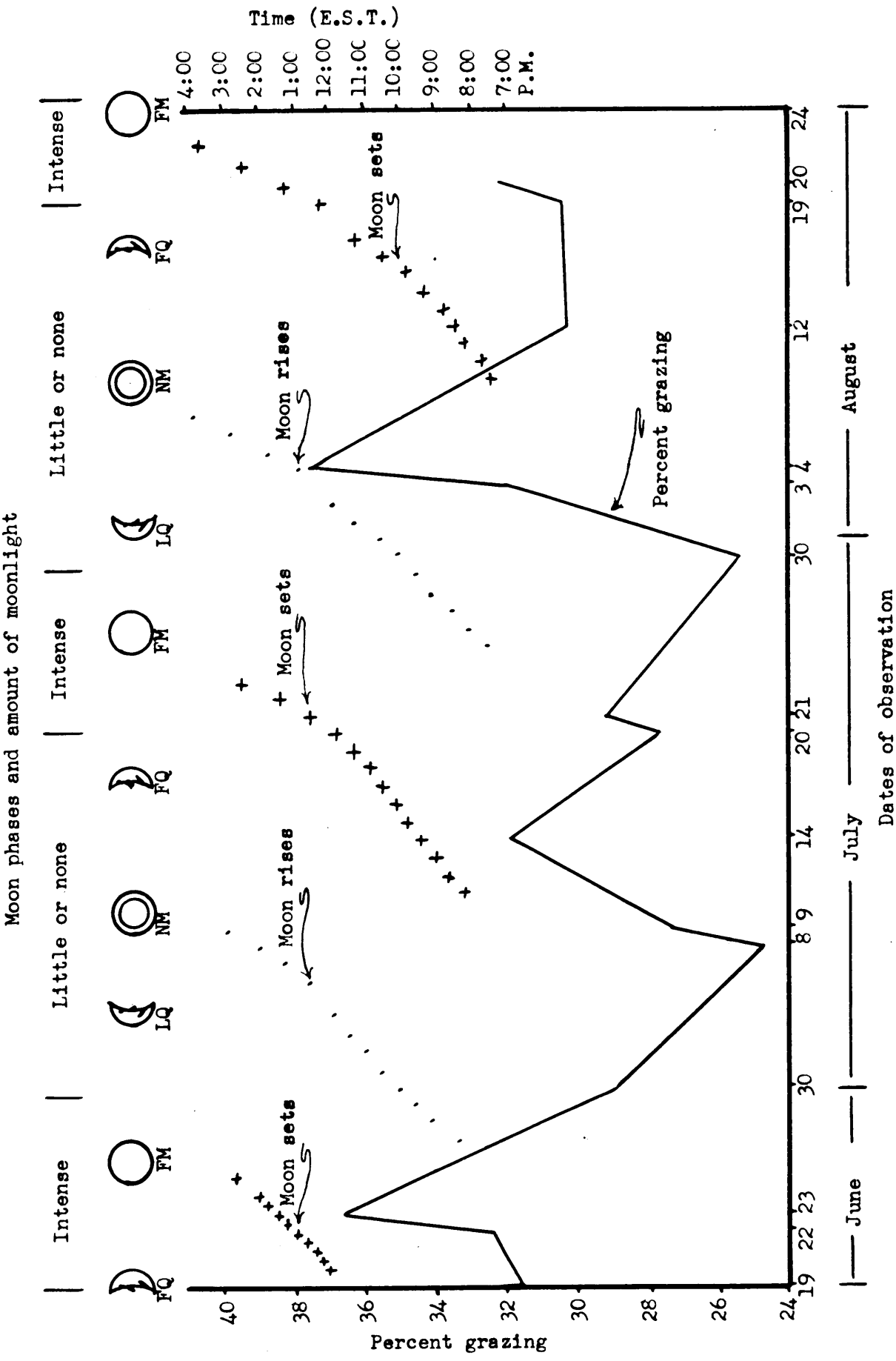


Graph 1. Grazing time (average of all mixtures) of beef cattle as influenced by maximum and minimum daily temperatures.

July 20, 21, and 30 when the maximum and minimum daily temperatures were medium to high. High grazing activity occurred during June 23, a day with high maximum and medium minimum daily temperatures.

The moon apparently had no effect on the grazing behavior of the steers in this experiment (Graph 2). During two of the intense moonlight periods, June 19 to July 1, and August 20, the percent of grazing was fairly high, but during a similar period, July 20 to July 30, the grazing activity was quite low. High activity was noted June 22 and 23, medium activity August 20, and low activity July 20, 21, and 30 near the full moon phase. During July 8 and 9, the grazing was quite low but during August 3 and 4, the grazing activity was much higher; both periods were between the last quarter and new moon phase. There was no consistent relationship of grazing activity to the moon phases. Undoubtedly many unknown factors contributed to the difference among days.

The animal grazing behavior for two consecutive days showed more similarity than observations taken for non-consecutive days. The variance between consecutive days was 731.99 as compared with 2164.52 for non-consecutive days. The data suggest that beef cattle are not creatures of habit in the sense that they graze exactly the same amount from day to day. The greater similarity in grazing habits of consecutive days as compared to non-consecutive days, indicates that some climatic or light factors do influence grazing habits. It is also possible that pastures are more nearly alike on consecutive than on non-consecutive days.

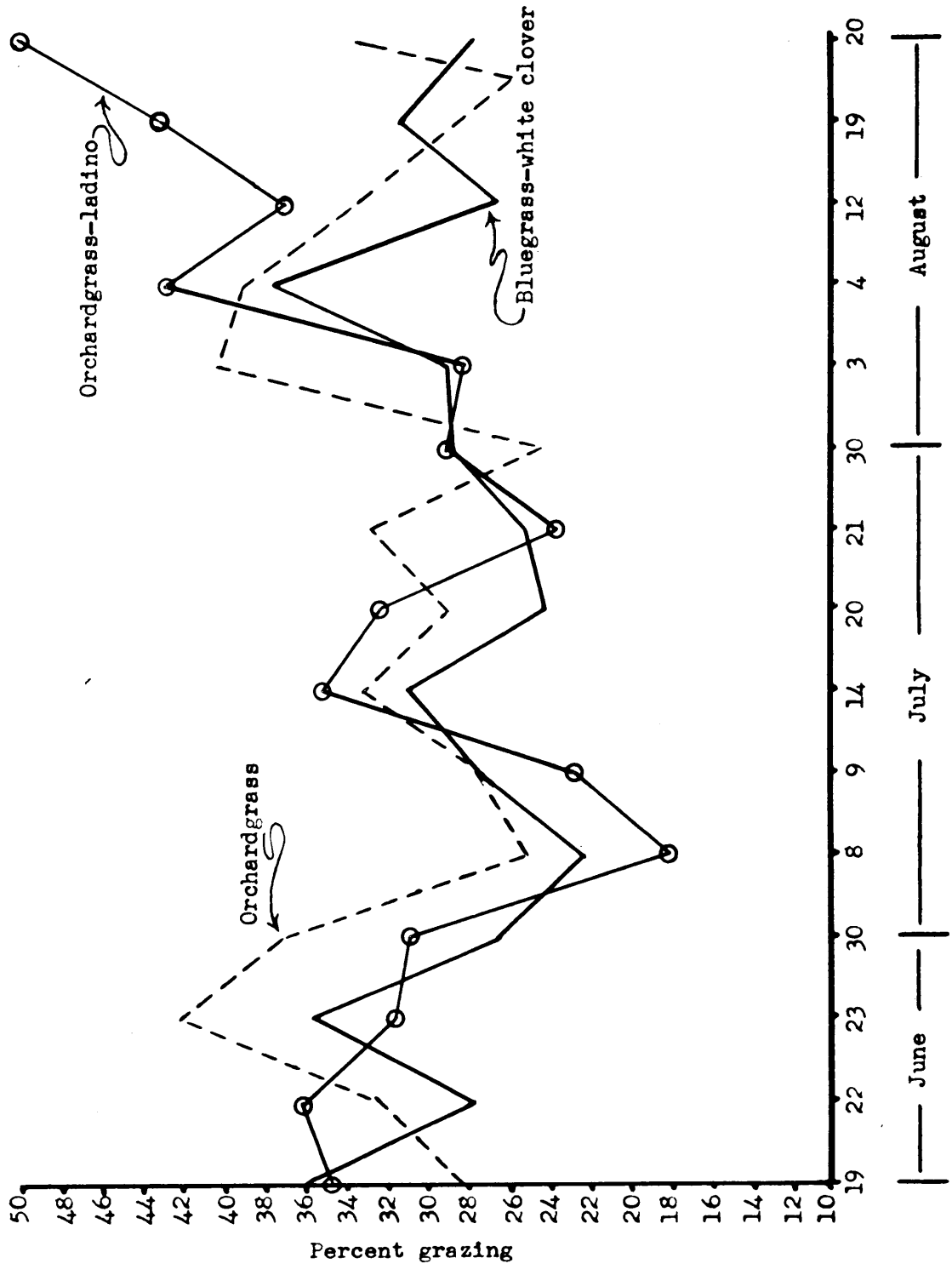


Graph 2. Beef cattle grazing as related to the moon.

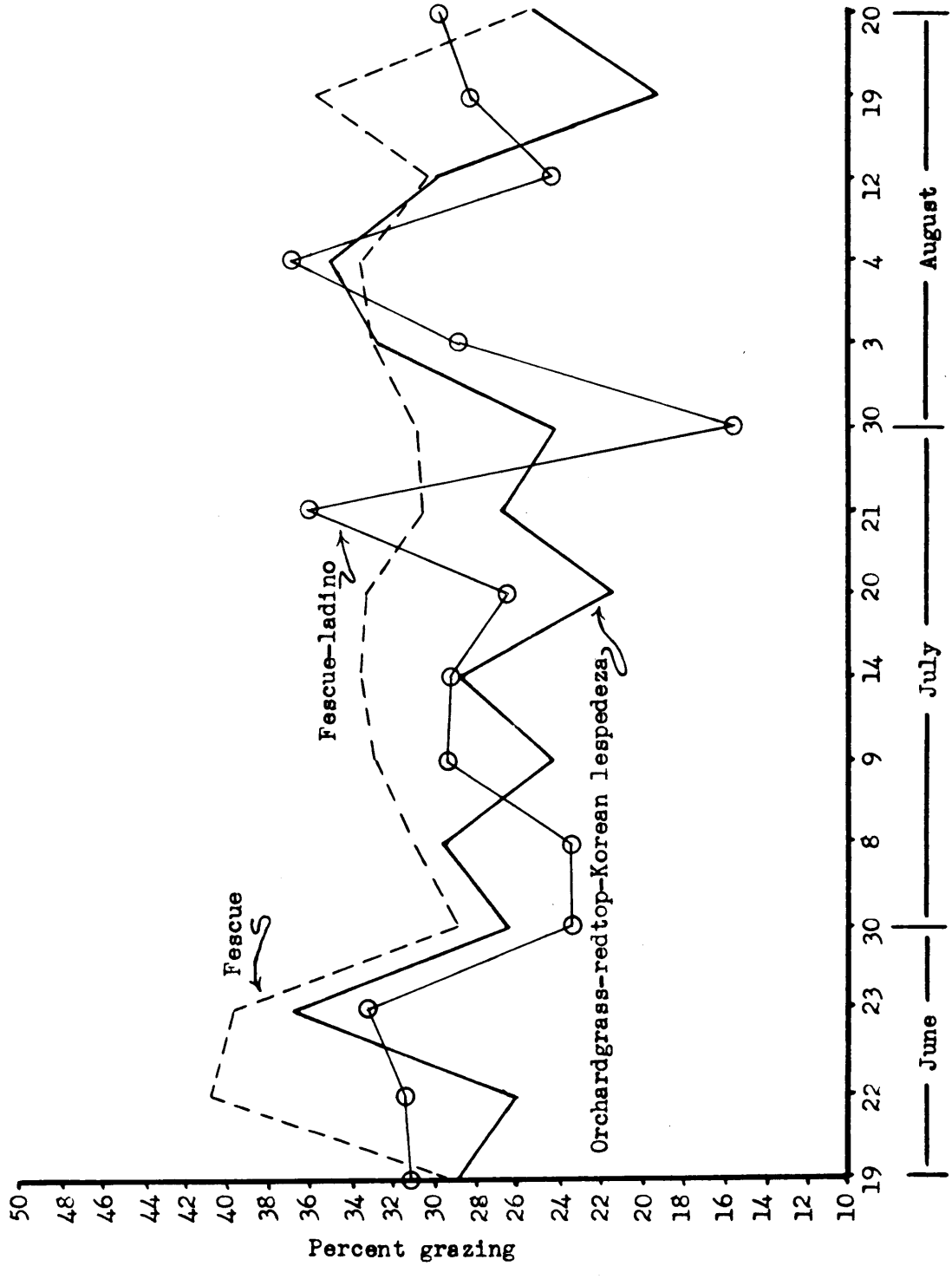
Although the interaction of days by mixtures was not significant (Table 1), there was much variation in grazing behavior among the mixtures during different days (Graphs 3 and 4). The technique employed and the use of only two of the three replications in the experiment was not adequate to obtain statistical significance. The subsequent paragraphs give some reasons for the mixture by day variability.

The grazing habits on fescue pasture varied considerably from the other pastures on June 22. Apparently a palatability factor entered into the increased grazing activity for both replications, ranged about 50 percent of 9-10 inch and about 50 percent of 1-1/2 to 2 inch herbage providing ample pasture for the steers. The high grazing percentage for orchardgrass on the 23rd of June undoubtedly is a reflection of the lack of available herbage for the animals in replication I. The fescue plots on the 23rd of June averaged 45 percent of 8 inch or higher grass so a lack of herbage is not reflected in the high percent of grazing.

Low grazing time was recorded for orchardgrass-ladino mixture as compared to other mixtures on July 8. The lot in replication I consisted of 35 percent of 7-8 inch and 65 percent of 2 to 2-1/2 inch herbage as compared to a nearly ungrazed lot in replication II of 75 percent of 8 inch and 25 percent of 2-3 inch herbage. Apparently sufficient palatable herbage remained for orchardgrass-ladino mixture that it took less time to get a fill. The other mixtures were in various stages of grazing.



Graph 3. Grazing time of three pasture mixtures for different dates.



Graph 4. Grazing time on different dates of three pasture mixtures.

The fescue grazing percentage was high on July 9 and 14, and the amount of herbage was 50 percent or more of 6 inch or taller herbage with some ranging to 14 inches. Apparently the low palatability of fescue influenced the grazing behavior.

The fescue-ladino mixture showed considerable need for rain on July 21; hence the ladino clover was not recovering rapidly, leaving mostly the fescue. Apparently the animals disliked fescue which resulted in a longer grazing time to obtain a fill.

The extremely low grazing time for fescue-ladino mixture on July 30 is the reflection of new pastures in which the ladino clover had practically recovered, giving more variety to the available herbage, hence the animals attained a fill more quickly.

The high percentage of grazing for orchardgrass on August 3 reflects a lack of succulence, hence a longer time to attain a fill. Sufficient herbage was furnished by the lots which consisted of 45 percent of 7-12 inch and 50 percent of 9-13 inch herbage respectively. A lack of rain undoubtedly reduced the succulence of the orchardgrass.

The low percent of grazing for orchardgrass-redtop-Korean lespedeza for the 19th of August is not explainable. The high activity on orchardgrass-ladino mixture on the 19th and 20th of August, may be associated with a low herbage supply. The hot weather and lack of rain eliminated the ladino clover and reduced the succulence of the orchardgrass.

The amount of herbage available and its palatability both contribute to the amount of time spent to obtain a fill. The percent of grazing activity for a day may be related to the palatability and amount of herbage present.

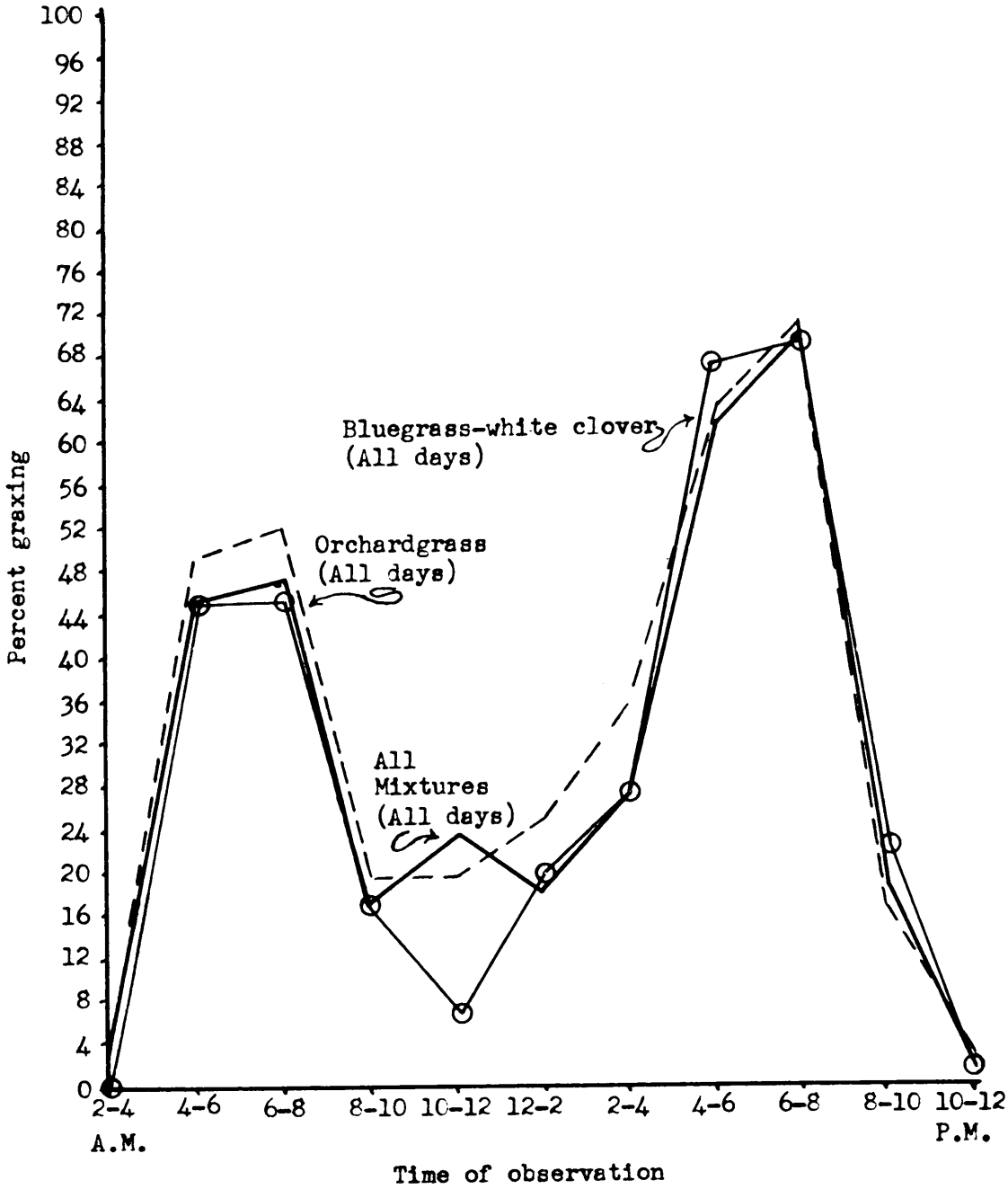
The time of grazing fell into two major periods and one minor period during the day (Table 3 and Graphs 5 and 6). The major periods were in the morning and evening with the minor period occurring during mid-day. The evening period was the period of greatest grazing activity. About 45.7 to 49.4 percent of the animals were active from 4:00 to 8:00 A. M. During the mid-day periods the grazing intensity was low (16.5 to 27.5 percent), but by 6:00 P. M., 70.6 percent of the steers were grazing. By 8:00 P. M., or about dark, the steers were bedding down for the night.

The interaction of time and mixtures was not significant at either the five or one percent levels (Table 1). However, a variance in the data may be attributed to the differences in the amount of grazing on the mixtures during mid-day (Graph 5). The steers on bluegrass-white clover lots grazed very little during the mid-day period, but the steers on the other mixtures behaved in a manner similar to the average activity curve for all mixtures.

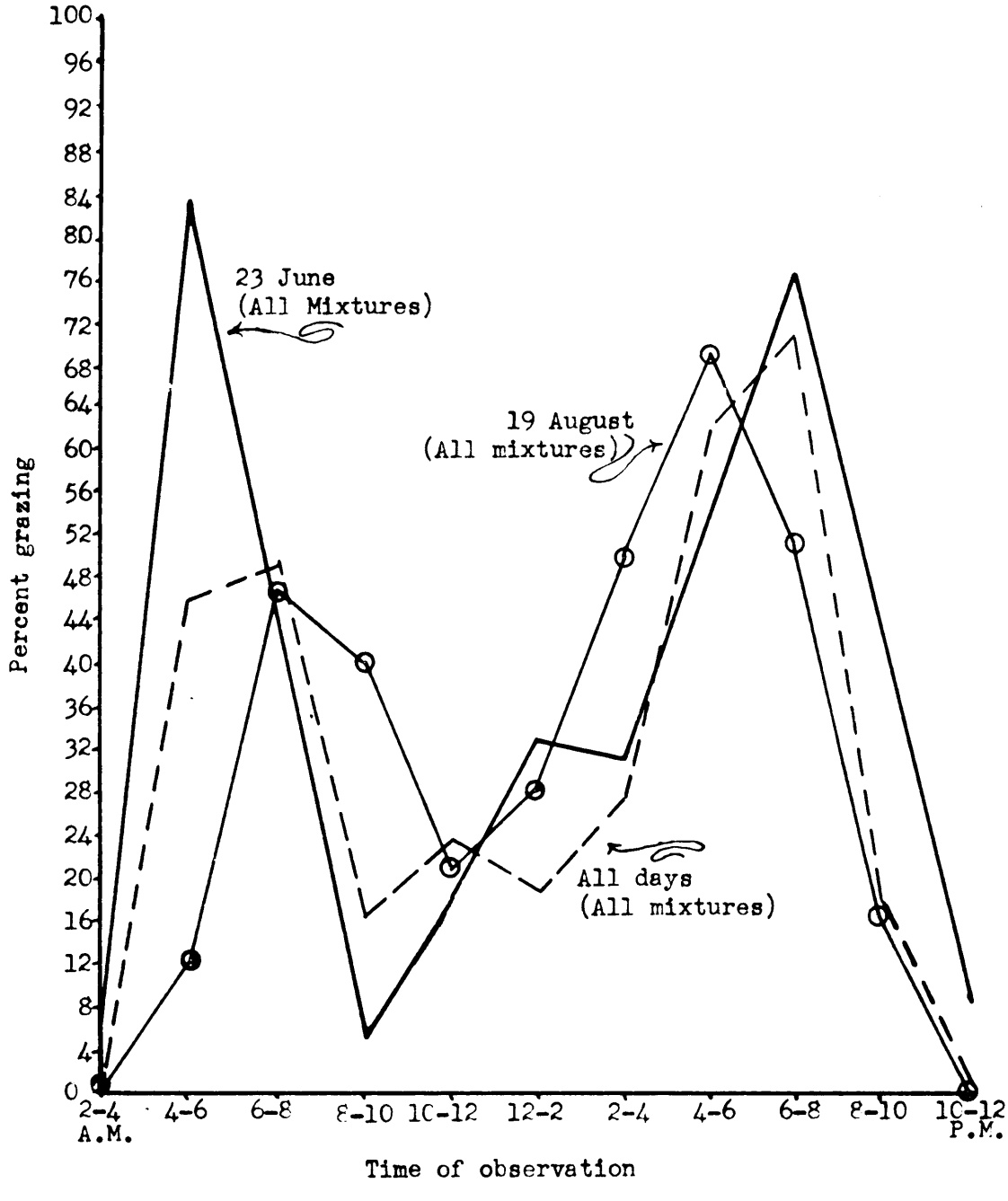
The amount of animal grazing for a given time varies among days, hence the highly significant day and time interaction (Tables 1 and 4 and Graph 6). On June 23, 82.6 percent of the animals were grazing

Table 3. Steer grazing times spent on different mixtures during different periods during a day (results are average of 15 days).

Mixtures	Time of observation											
	A. M.						P. M.					
	2-4	4-6	6-8	8-10	10-12	12-2	2-4	4-6	6-8	8-10	10-12	Average
Bluegrass-Virginia white clover	0.0	45.1	45.6	16.1	6.7	20.0	27.5	67.1	70.0	22.8	0.0	29.2
Orchardgrass	1.7	48.6	52.0	19.3	19.2	25.0	35.0	63.3	71.2	16.1	3.3	32.3
Kentucky 31 fescue	0.0	49.7	48.2	15.0	34.9	15.0	33.2	66.1	76.2	19.2	1.1	32.6
Orchardgrass-ladino clover	1.7	47.1	57.1	23.3	32.5	23.1	23.9	59.8	70.2	22.5	1.7	33.0
Kentucky 31 fescue-ladino clover	0.0	44.5	41.9	10.6	27.5	13.9	23.6	63.6	67.5	16.1	3.3	28.4
Orchardgrass-red top-Korean lespedeza	3.3	39.3	51.7	14.5	20.8	15.0	21.7	51.8	68.3	15.6	3.3	27.8
Average	1.1	45.7	49.4	16.5	23.6	18.7	27.5	62.0	70.6	18.7	2.1	



Graph 5. The grazing behavior of steers varied with mixtures within a day.



Graph 6. The grazing behavior of steers within a day varied with days.

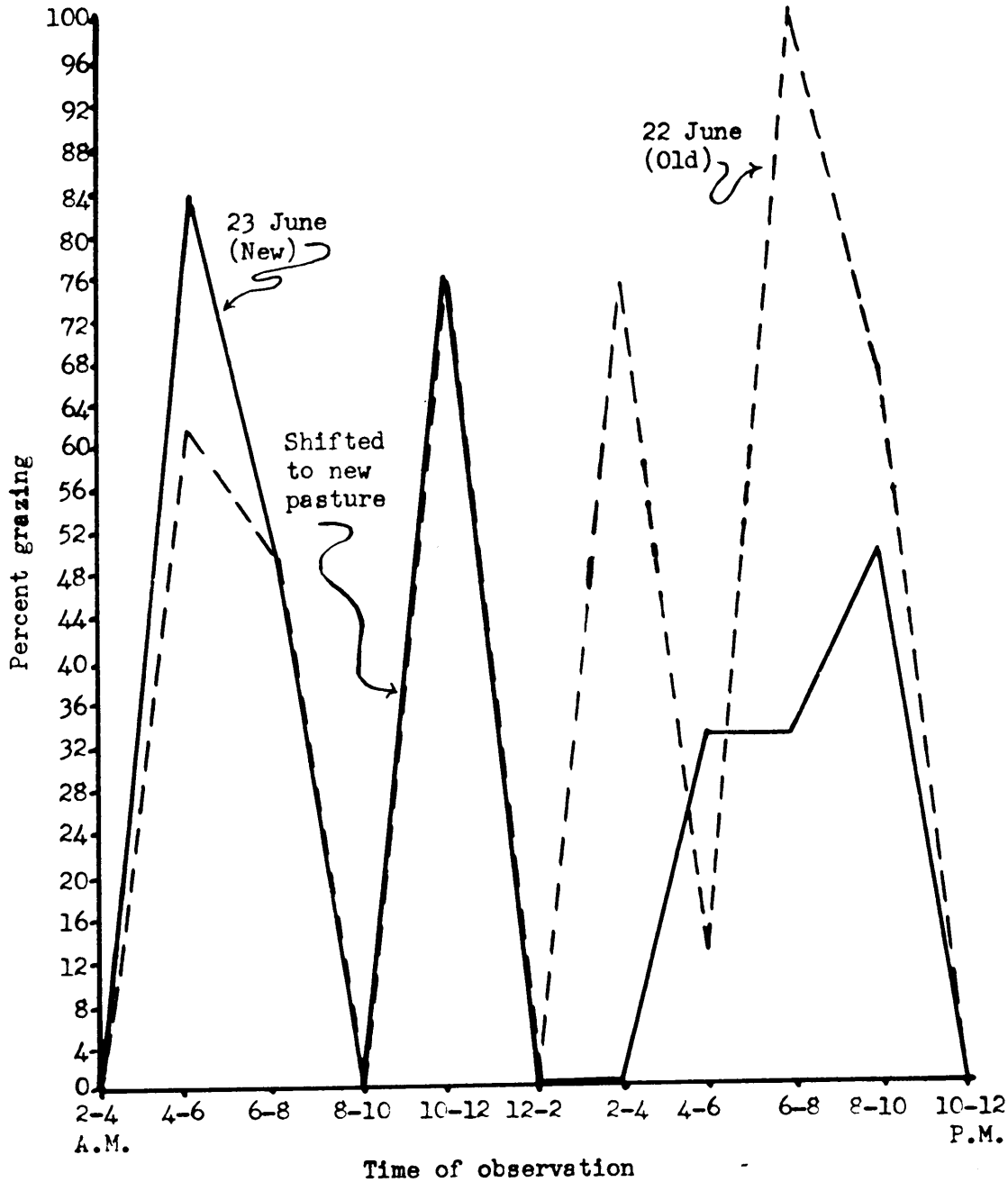
Table 4. Grazing time of steers as influenced by the time of day on different days.

Time of Observation	Dates of observation															Average
A. M.	19 June	22 June	23 June	30 June	8 July	9 July	14 July	20 July	21 July	30 July	3 August	4 August	12 August	19 August	20 August	
2:00-4:00	0.0	0.0	4.2	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	1.1
4:00-6:00	42.7	51.2	82.6	46.4	52.1	49.3	54.2	45.8	41.3	49.7	31.9	50.0	45.0	12.0	31.6	45.7
6:00-8:00	44.0	33.3	44.2	41.2	52.1	61.6	39.3	54.2	34.7	32.4	61.1	57.4	65.9	46.3	73.6	49.4
8:00-10:00	23.6	13.9	5.6	9.3	5.1	14.3	5.1	2.8	13.9	9.7	16.7	24.2	16.6	40.3	45.8	16.5
10:00-12:00	11.8	32.6	17.4	12.5	8.3	17.4	13.9	35.4	22.9	14.6	44.5	60.6	7.2	20.8	34.0	23.6
P. M.																
12:00-2:00	26.4	23.6	33.3	4.2	15.3	6.9	47.3	6.3	25.0	0.0	16.7	20.8	0.0	29.2	25.0	18.7
2:00-4:00	22.9	18.8	31.3	29.2	11.1	18.0	21.5	27.1	20.8	25.0	42.4	49.5	15.4	50.0	29.2	27.5
4:00-6:00	72.9	61.1	54.2	63.5	59.0	50.7	59.4	53.5	57.3	84.4	67.6	52.6	78.9	68.8	45.5	62.0
6:00-8:00	71.8	80.8	75.9	81.9	58.8	59.3	83.3	59.7	80.6	62.0	67.0	80.0	79.3	50.6	65.5	70.6
8:00-10:00	29.6	41.2	45.1	25.4	13.0	22.2	26.4	20.8	15.3	1.4	2.8	5.6	11.1	18.1	2.8	18.7
10:00-12:00	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	2.8	12.5	0.0	0.0	2.1
Average	31.4	32.4	36.6	28.9	25.0	27.3	31.9	27.8	29.1	25.4	32.1	37.4	30.2	30.5	32.1	

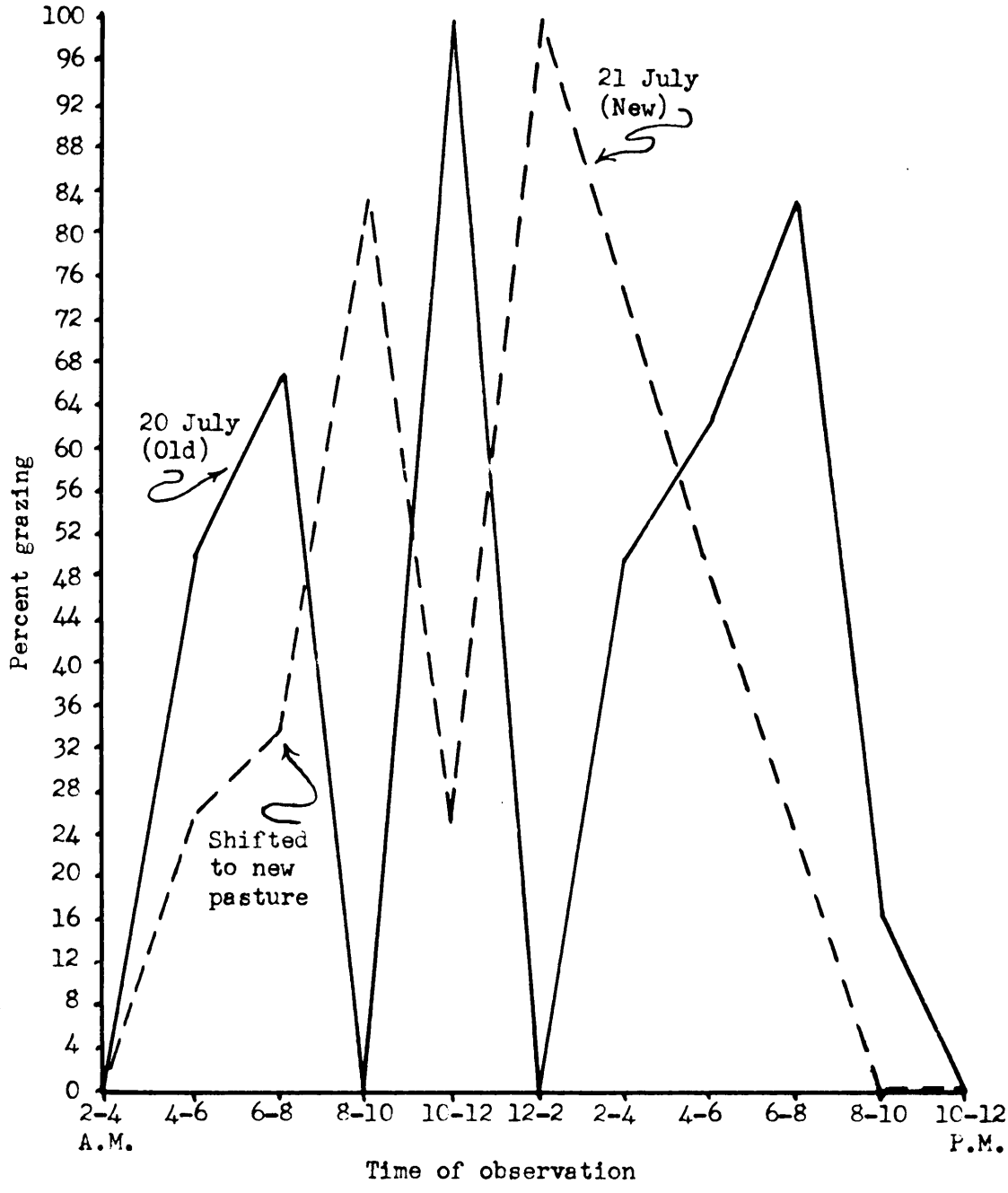
from 4:00 to 6:00 A. M., and 45.1 percent from 8:00 to 10:00 P. M., as compared to 12.0 percent and 18.1 percent, respectively, for August 19. Both of these days differ considerably from the average grazing curve for all mixtures for the summer (Graph 6). There is also much variance for time among other days. Six out of 12 steer lots were turned into new pasture on June 20 where there was abundant herbage. Observations taken on June 22 and 23 show a high grazing incidence for these days. The new herbage in these lots may have encouraged peak grazing periods during these days as compared to the results for given times during other days.

The herbage was grazed closely on 10 out of 12 lots on August 19. The lack of adequate luscious pasture herbage may have caused the erratic grazing behavior during this day as compared to other days. The lack of adequate palatable herbage may account for the low grazing incidence during early morning and the low incidence during mid-day.

The steers did not follow a precise pattern when turned into new pastures. Steers, grazing an orchardgrass-ladino mixture on June 22, were turned into a fresh field of the mixture on June 23. After the steers were given a fresh pasture, the grazing incidence was low when compared with the previous day (Graph 7). The low grazing incidence may be associated with a quick fill. The opposite behavior was observed on orchardgrass pastures during July 20 and 21. When the steers grazed a new pasture on July 21, they grazed heavily and shifted their afternoon period of grazing to nearer noon than the day before (Graph 8). This indicates that the grazing pattern from day to day is



Graph 7. The effect of new and old orchardgrass-ladino clover pasture on grazing behavior of steers.



Graph 8. The effect of new and old orchardgrass pasture on steer grazing behavior.

influenced by pasture conditions. These inconsistencies contribute to the significance of the interactions of time and days; time and mixtures; and time, days, and mixtures.

EXPERIMENT II - DAIRY GRAZING EXPERIMENT

Procedure

An experiment was established in 1950 to measure the effect of pasture management and grain feeding on milk production. The pasture treatments were: (a) orchardgrass-ladino clover, 10 lots grazed rotationally; (b) ladino clover, 4 lots grazed rotationally; and (c) orchardgrass-ladino clover, 2 lots grazed rotationally.

A 24-acre land area was divided into 6 lots of 4 acres each making 2 replicated blocks with three lots per block. The three treatments were assigned at random to the three lots within a replication. Each lot was supplied with running water, but the amount of shade varied for the lots.

The number of Holstein-Fresian cows per lot varied from 3 to 6 depending upon the herbage available. The rations of the three test cows on each lot were as follows: (1) no grain, (2) 1 pound of grain per 9.7 pounds of milk produced, and (3) 1 pound of grain per 4.6 pounds of milk produced, respectively.

Data on animal behavior were taken for 13 different days during June, July, and August, 1953. Data were recorded for all animals in a given lot, but in this report only the test cows are considered. In this experiment more observations were obtained at half hour intervals than for the beef cattle experiments to obtain more precise data. The closer intervals should give a more accurate estimate of

the daily grazing patterns. The periods of observation were taken at the following times:

A. M. - 2:00, 3:00, 7:30, 8:00, 8:30, 9:00, 9:30, 10:00, 10:30, 11:00, 11:30, and 12:00.

P. M. - 1:00, 1:30, 2:00, 2:30, 3:00, 6:30, 7:00, 7:30, 8:00, 8:30, 9:00, and 10:00.

The cows were removed from the pastures for milking twice daily at approximately 4:00 to 7:00 A. M., and 3:30 to 6:00 P. M. A statistical analysis was made using a split-split-split plot design (Table 5).

During August 17 and 18 continuous observations were made during the period between the morning milking and the time when the cows were removed from pasture for the evening milking. Group data were taken for the three test cows in a lot on two of the three pasture treatments. Observations were made at half hour intervals for the same period by inspection of the continuous observation data. The activity at thirty minute intervals was treated in the same manner as the previous dairy observations.

Results and Discussion

The cow grazing times for the three pasture treatments did not differ (Table 5) even though the values ranged from 8.8 hours to 11.0 hours. Table 6 gives a summary of the grazing time for the various pasture treatments.

Table 5. Analysis of variance, dairy experiment.

Item	D/F	MS	F
Replication	1	0.0000	0.0000
Pasture treatment	2	4.4535	3.8542
Error a	2	1.1555	
Grain levels	2	0.4240	0.7207
Cows X treatment	4	0.5755	0.9782
Error b	6	0.5883	
Days	12	3.0123	35.4454**
Days X treatment	24	0.4335	4.8274**
Days X grain levels	24	0.0725	0.8073
Days X grain X treatment	48	0.0917	1.0212
Error c	108	0.0898	
Time	23	16.6073	102.2617**
Time X treatment	46	0.6347	3.9083**
Time X grain levels	46	0.0953	0.9636
Time X grain X treatment	92	0.2072	1.2759*
Time X days	276	0.5073	3.1238**
Time X days X treatment	552	0.2571	1.5831
Time X days X grain	552	0.0745	0.4587
Time X days X grain X treatment	1104	0.0688	0.4236
Error d	2691	0.1624	
Total	5615		

* 5 percent level of significance.
** 1 percent level of significance.

Table 6. Time spent grazing by dairy cows under three pasture treatments and under three grain levels (results are averages for 13 days).

Grain Levels	10 lots Ladino-Orchardgrass	4 lots Ladino Clover	2 lots Ladino-Orchardgrass	Average
None	38.8	40.9	46.3	42.0
Low	37.2	37.2	44.7	39.7
Medium	39.7	31.4	46.3	39.1
Average	38.6	36.5	45.8	40.3
Hours per day	9.3	8.8	11.0	

The grazing time of the cows fed different grain levels did not differ, the time ranged from 39.1 to 42.0 percent (Table 6).

The grazing time for the various days differed. The days were ranked at the five and the one percent levels by Duncan's New Multiple Range Test (6), (Table 7). Any days not underscored by the same line are significantly different at the level indicated. The days fall into general groups showing that there is little relationship between dates within the same week or month.

In general, when the maximum temperatures were high, the grazing time decreased and when maximum temperatures were low, grazing time increased (Table 8 and Graph 9). Two high peaks of grazing occurred during June 15 and August 6 to 11 when the temperatures were low. On July 10 and 23, moderate grazing accompanied a moderate drop in temperature. During high temperature periods, July 2, July 17, and July 28, a slump in daily grazing activity occurred.

The moon apparently had no influence on the grazing behavior of the dairy cows in this experiment (Graph 10). During two periods of intense moonlight the grazing activity was on the decline, while at another intense moonlight period it reached a peak. Grazing was high on two occasions and low on one occasion during periods of low or no moonlight. Grazing was low during two full moon periods but was at a peak in another full moon period. Grazing was high on two occasions and low on one occasion during the new moon phase.

Table 7. Days ranked in order by the Duncan Multiple Range Test.

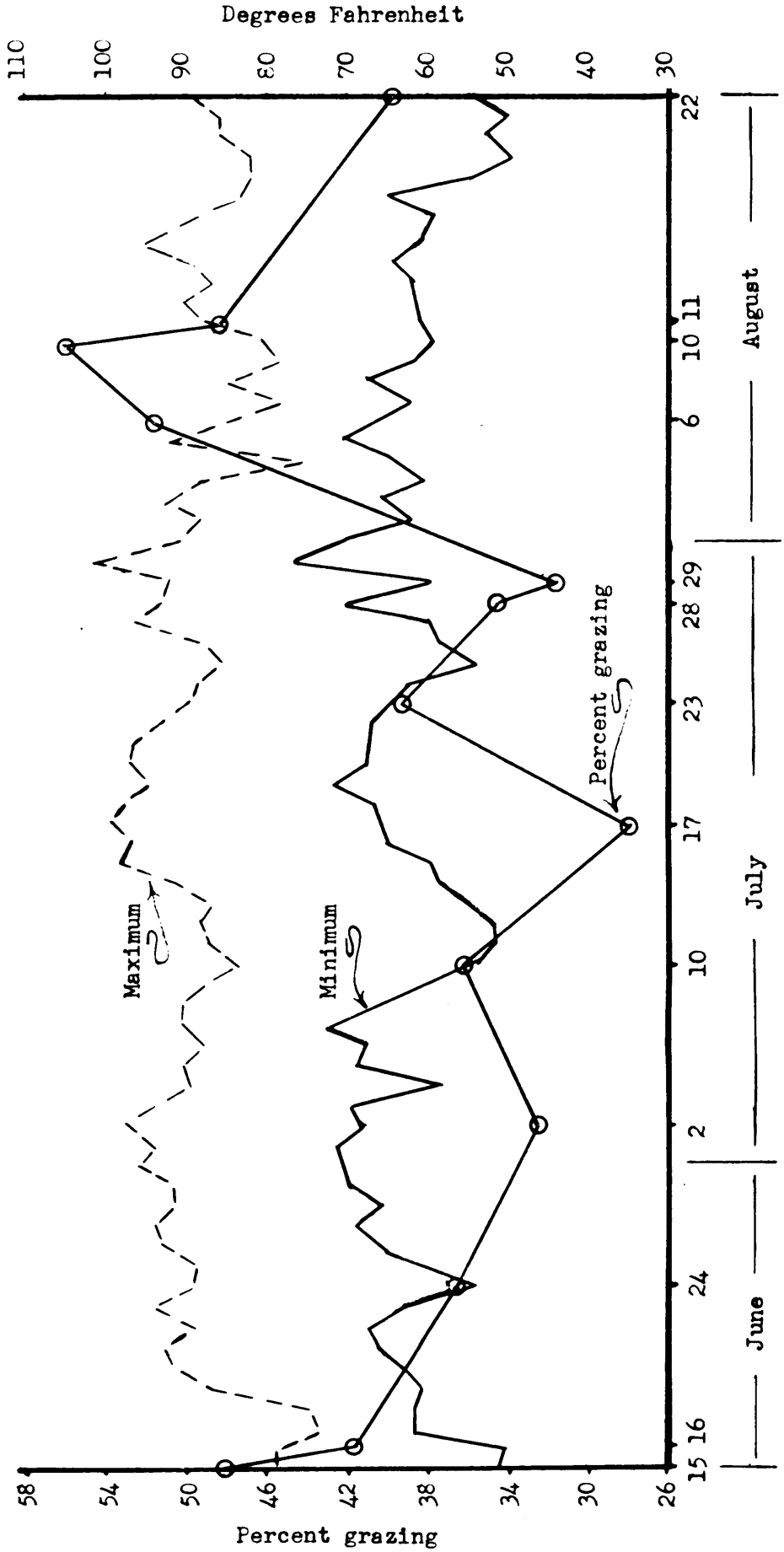
Date of observation											
17 July	29 July	2 July	28 July	10 July	24 June	23 July	22 August	16 June	15 June	11 August	6 August	10 August
0.280	0.319	0.324	0.345	0.361	0.366	0.394	0.398	0.419	0.472	0.481	0.516	0.560

5 percent

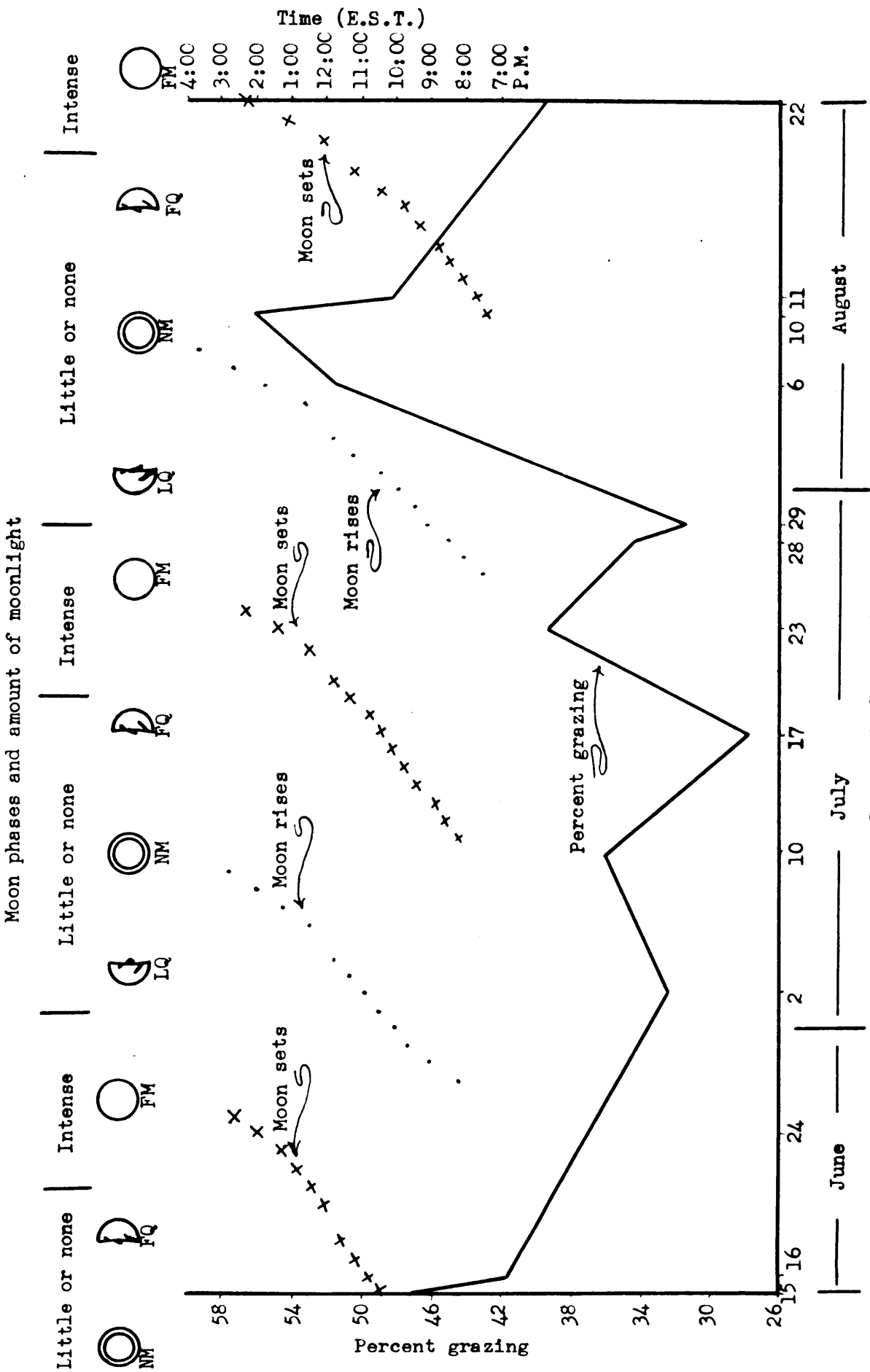
1 percent

Table 8. Grazing time of dairy cows for different days on three pasture treatments.

Pasture treatments	Date of observation													
	15 June	16 June	24 June	2 July	10 July	17 July	23 July	28 July	29 July	6 August	10 August	11 August	22 August	Average
Orchardgrass-ladino (10 lots)	47.9	43.1	37.5	33.3	32.6	24.3	31.9	31.3	37.7	45.1	56.3	45.8	37.5	38.6
Ladino (4 lots)	33.3	33.3	37.5	32.6	28.5	23.6	42.4	31.9	27.8	53.5	54.2	37.5	38.2	36.5
Orchardgrass-ladino (2 lots)	60.4	49.3	34.7	31.3	47.2	36.1	43.8	40.3	33.3	56.3	57.6	61.1	43.8	45.8
Average	47.2	41.9	36.6	32.4	36.1	28.0	39.4	34.5	31.9	51.6	56.0	48.2	39.8	40.3



Graph 9. Grazing time (average of all pasture treatments) of dairy cattle as influenced by maximum and minimum daily temperatures.



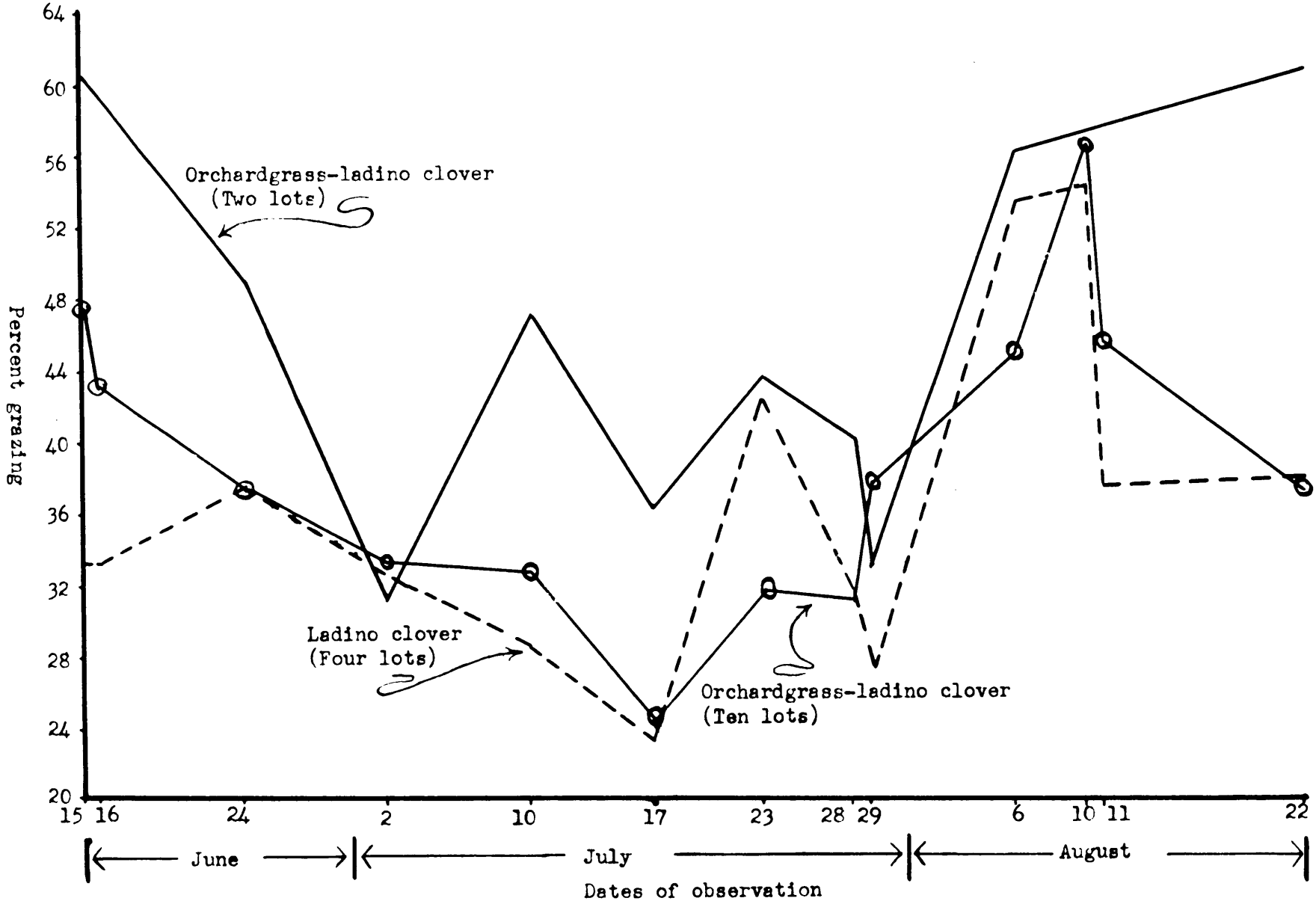
Graph 10. Dairy cattle grazing as related to the moon.

The day and pasture treatment interaction is significant at the one percent level (Table 5), as the three pasture treatments did not give uniform data on given days (Table 9 and Graph 11). When considering the orchardgrass-ladino clover mixtures, there was more day to day variation for the 2-lot rotational than the 10-lot rotational grazing plan. This may be attributed to greater day to day differences in available pasturage in the 2-lot system than the 10-lot plan. In the 10-lot grazing system, cows were concentrated on a small area where the feed was grazed down in three days. In the 2-lot grazing plan, cows stayed on a given pasture for more than two weeks. The large day to day variation of the 2-lot system probably was produced by the gradual change from the large amount of fresh herbage when first turned into a lot to a small amount of herbage on a fouled pasture prior to rotating to a new pasture.

The amount of grazing for the various observation times for all days together was different. A Duncan Multiple Range Test was applied at the five and one percent levels to the times (Table 10). Times from various parts of the day were similar while others were not. Any observation times not underscored by the same line are significantly different at the level indicated. This test shows very clearly the difference in times. The time of grazing (average for all days) fell into two major periods and one minor period during the day (Table 11 and Graph 12). The major periods were in the morning and evening following the return of the cows to the pasture after milking with the

Table 9. Grazing time for different days and different pasture treatments.

Pasture treatments	Date of observation													
	15 June	16 June	24 June	2 July	10 July	17 July	23 July	28 July	29 July	6 August	10 August	11 August	22 August	Average
Orchardgrass-ladino (10 lots)	47.9	43.1	37.5	33.3	32.6	24.3	31.9	31.3	37.7	45.1	56.3	45.8	37.5	38.6
Ladino (4 lots)	33.3	33.3	37.5	32.6	28.5	23.6	42.4	31.9	27.8	53.5	54.2	37.5	38.2	36.5
Orchardgrass-ladino (2 lots)	60.4	49.3	34.7	31.3	47.2	36.1	43.8	40.3	33.3	56.3	57.6	61.1	43.8	45.8
Average	47.2	41.9	36.6	32.4	36.1	28.0	39.4	34.5	31.9	51.6	56.0	48.2	39.8	40.3



Graph 11. Time spent grazing by dairy cows on three pasture treatments.

Table 10. Observation times ranked by Duncan Multiple Range Test.

Time of observation																					
P.M.	P.M.	A.M.	P.M.	A.M.	A.M.	A.M.	A.M.	P.M.	P.M.	P.M.	P.M.	A.M.	A.M.	A.M.	Noon	P.M.	A.M.	P.M.	A.M.	A.M.	P.M.	P.M.
10:00	9:00	3:00	8:30	2:00	11:00	10:30	10:00	1:30	2:00	2:30	3:00	1:00	9:30	9:00	11:30	12:00	8:00	8:30	7:30	8:00	7:30	6:30	7:00
0.030	0.056	0.124	0.128	0.179	0.235	0.248	0.252	0.282	0.282	0.308	0.312	0.338	0.368	0.402	0.410	0.423	0.470	0.590	0.726	0.838	0.880	0.885	0.902

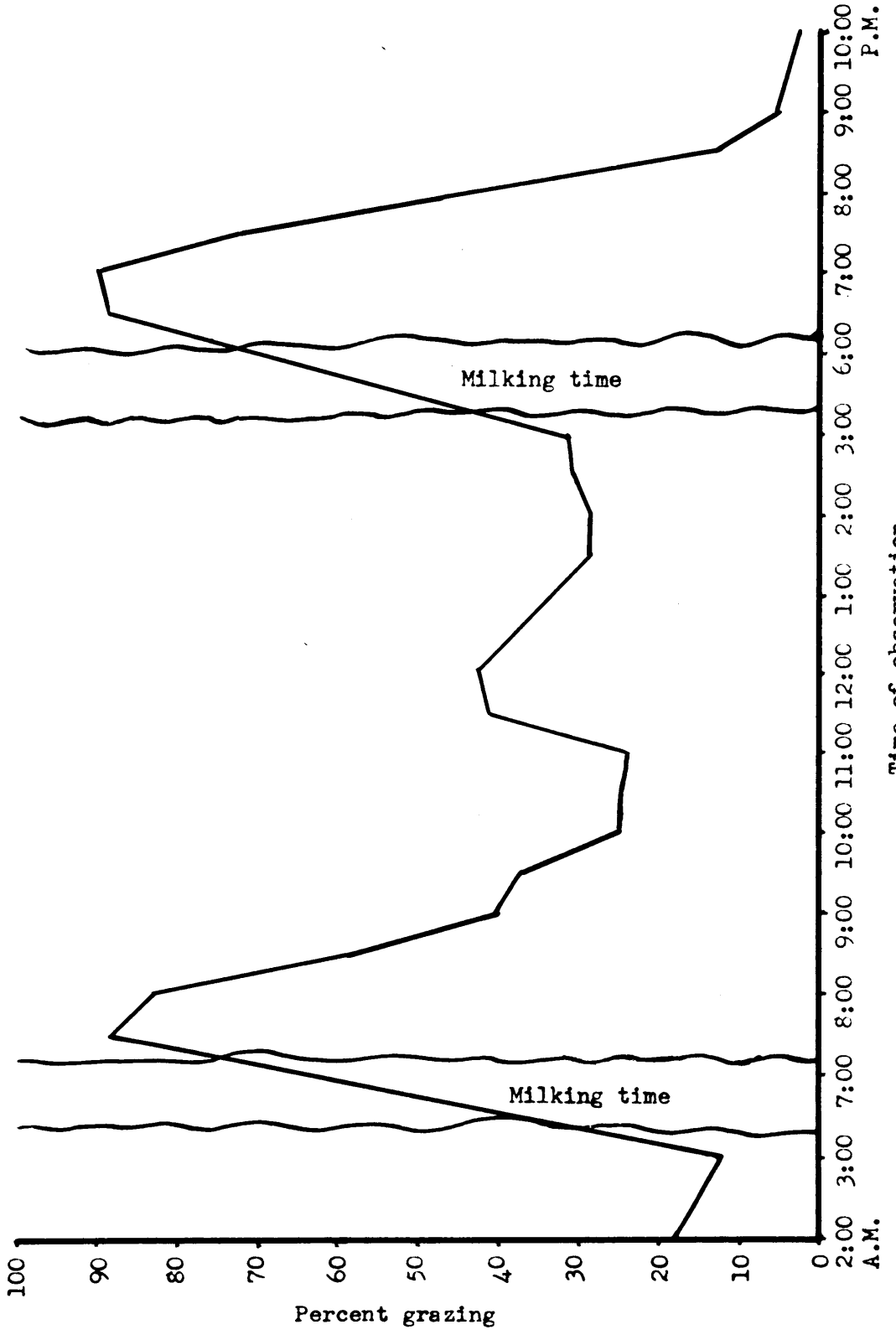
5 percent

1 percent

Table 11. Grazing time as related to time of day and to various pasture treatments with dairy cattle.

Pasture Treatments	Times of observation A. M.												
	2:00 3:00	3:00 4:00	4:00 7:30	7:30 8:00	8:00 8:30	8:30 9:00	9:00 9:30	9:30 10:00	10:00 10:30	10:30 11:00	11:00 11:30	11:30 12:00	
Orchardgrass-ladino (10 lots)	14.1	15.4		82.1	71.8	44.9	29.5	35.9	24.4	26.9	34.6	50.0	
Ladino (4 lots)	11.5	11.5	Milking	91.0	82.1	48.7	28.2	23.1	9.0	19.2	16.7	39.7	
Orchardgrass-ladino (2 lots)	28.2	10.3	Time	91.0	97.4	83.3	62.8	51.3	42.3	28.2	17.2	33.3	
Average	18.0	12.4		88.0	83.8	59.0	40.2	36.8	25.2	24.9	23.5	41.0	

Pasture Treatments	Times of observation P. M.															
	12:00 1:00	1:00 1:30	1:30 2:00	2:00 2:30	2:30 3:00	3:00 3:30	3:30 6:30	6:30 7:00	7:00 7:30	7:30 8:00	8:00 8:30	8:30 9:00	9:00 10:00	10:00 11:00	Average
Orchardgrass-ladino (10 lots)	35.9	30.8	23.1	35.9	34.6	30.8		84.6	91.0	69.2	35.9	14.1	6.4	3.9	38.6
Ladino (4 lots)	50.0	30.8	23.1	14.1	24.4	38.5	Milking	94.9	89.7	69.2	42.3	10.3	3.9	3.9	36.5
Orchardgrass-ladino (2 lots)	41.0	39.7	38.5	34.6	33.3	24.4	Time	85.9	89.7	79.5	62.8	14.1	6.4	1.3	45.8
Average	42.3	33.8	28.2	28.2	30.8	31.2		88.5	90.2	72.7	47.0	12.8	5.6	3.0	40.3

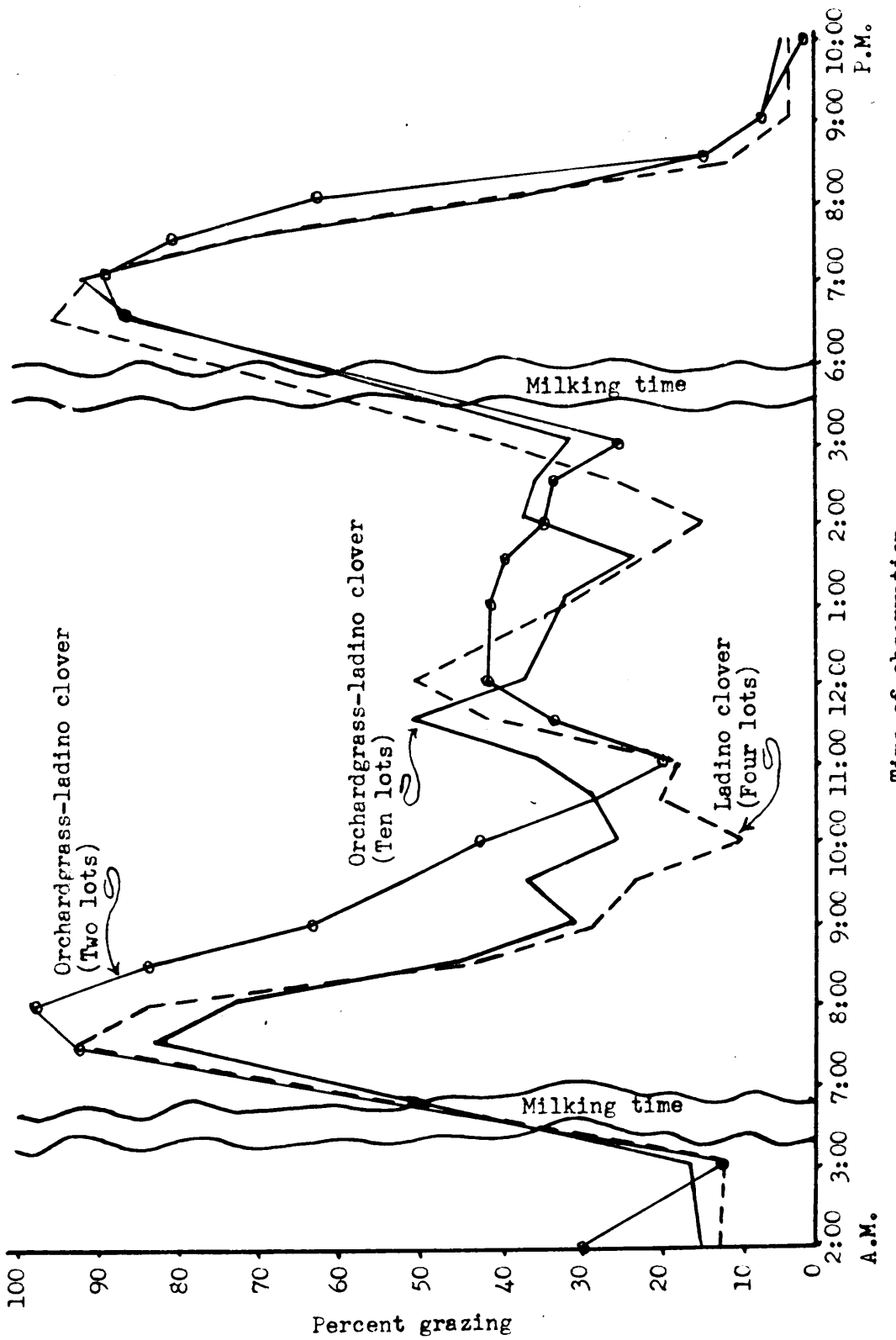


Graph 12. General dairy cow grazing curve for all pasture treatments for all days.

minor period occurring during mid-day. The evening period was the period of greatest grazing with about 88.5 to 90.2 percent as compared to about 83.8 to 88.0 percent during the morning period. The cows were bedded down for the night shortly after dark.

The interaction of times and pasture treatments was significant at the one percent level (Table 5), as shown by a difference in the percent of grazing on the pasture treatments at a given time of observation (Table 11 and Graph 13). There was more grazing on the two lot system from 8:00 to 10:00 A. M., than for the other pastures. A lower herbage supply on the 2-lot than on the 10-lot system at the time the data were taken may have increased the length of grazing period. During mid-day the grazing patterns for the mixtures were not consistent. The herbage supply on the 2-lot system was not grazed uniformly and the supply was somewhat short just before being removed to the alternate lot.

The time and day interaction was significant at the one percent level (Table 5) as shown by a difference in the amount of grazing at given times on given days (Table 12 and Graphs 14 and 15). The consecutive days of June 15 and 16 vary considerably from each other with 90 percent of the cows grazing at 9:30 A. M., on the 15th whereas none were grazing at the same hour on the 16th. A difference of approximately 40 percent occurred at 1:30 P. M., between these two days with a smaller difference of 20-25 percent at 2:30 P. M. The major variance between given observation times during different days seems to be between the major grazing peak following the morning milking and preceding

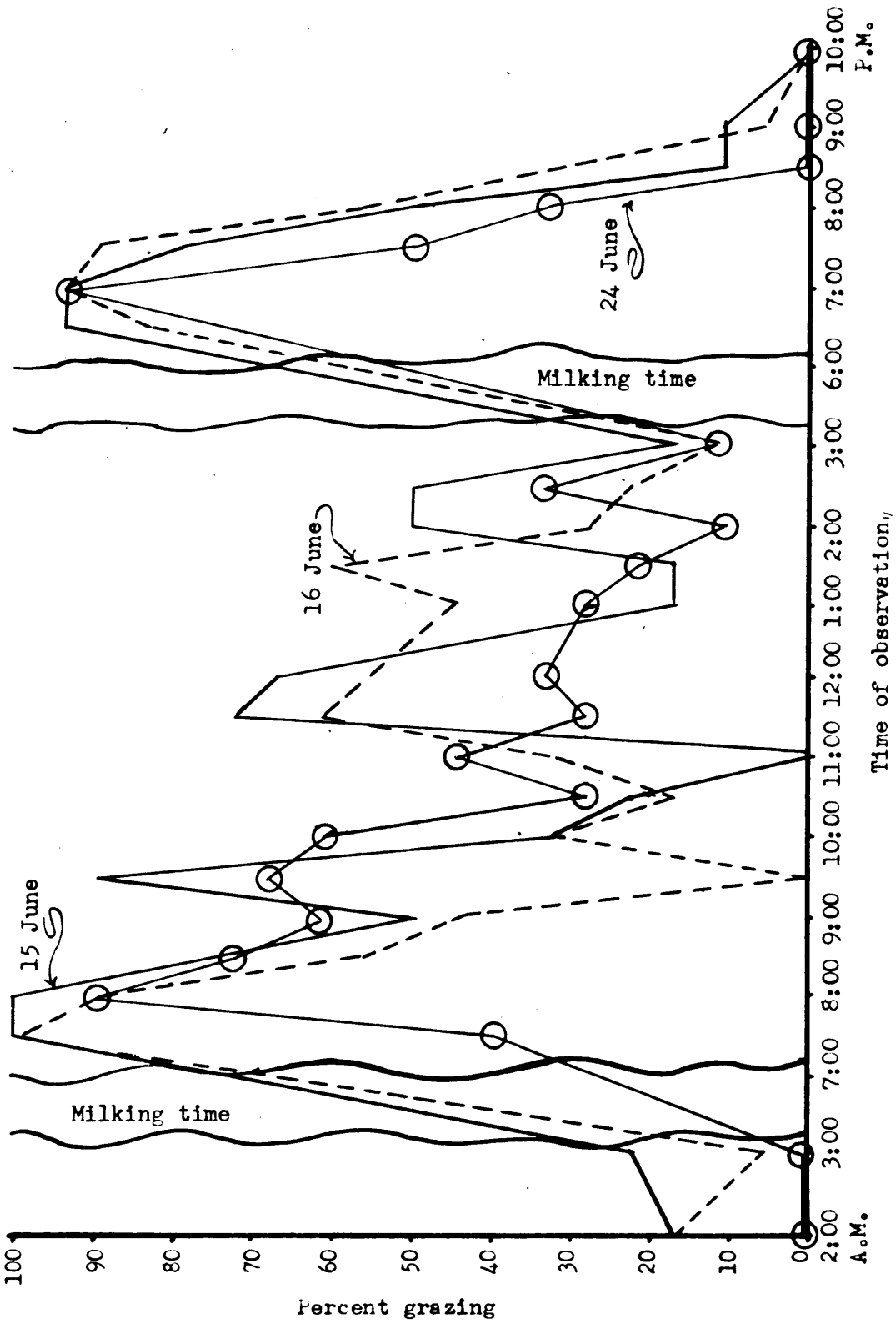


Graph 13. Grazing time curves (average for 13 days) for dairy cows on three pasture treatments.

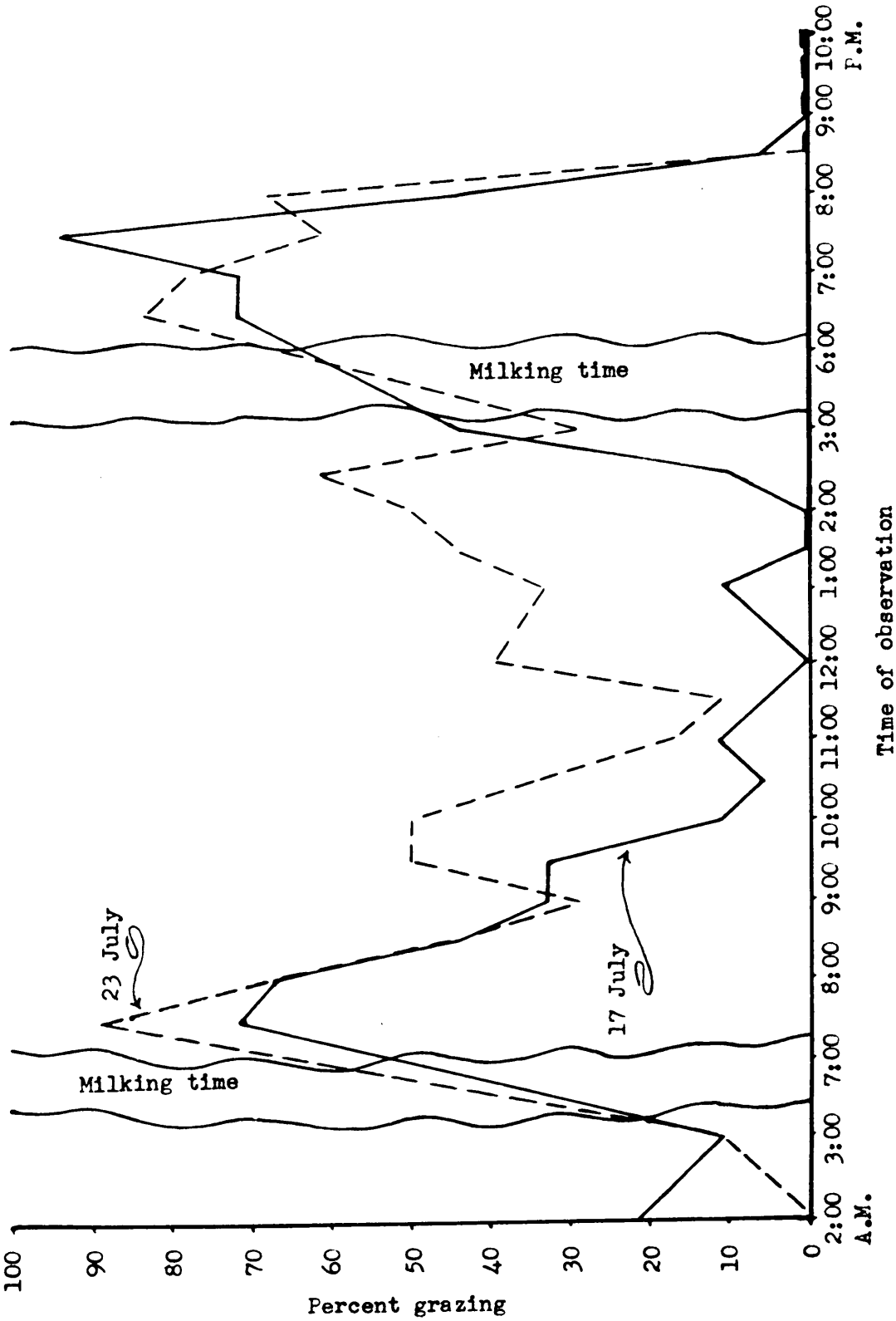
Table 12. Frequence of Grazing by dairy cows as influenced by day and time of day.

Dates of observation	Time of observation (A. M.)												
	2:00 3:00	3:00 4:00		7:30 8:00	8:00 8:30	8:30 9:00	9:00 9:30	9:30 10:00	10:00 10:30	10:30 11:00	11:00 11:30	11:30 12:00	
15 June	16.7	22.2		100.0	100.0	72.2	50.0	88.9	33.3	22.2	0.0	72.2	
16 June	16.7	5.6		100.0	88.9	55.6	44.4	0.0	33.3	16.7	33.3	61.1	
24 June	0.0	0.0	Milk-	38.9	88.9	72.2	61.1	66.7	61.1	27.8	44.4	27.8	
2 July	11.1	11.1	ing	100.0	94.4	27.8	0.0	16.7	0.0	5.6	16.7	0.0	
10 July	27.8	11.1		100.0	50.0	22.2	22.2	50.0	22.2	38.9	16.7	16.7	
17 July	22.2	11.1	Time	72.2	66.7	44.4	33.3	33.3	11.1	5.6	11.1	5.6	
23 July	0.0	11.1		88.9	66.7	44.4	27.8	50.0	50.0	33.3	16.7	11.1	
28 July	22.2	16.7		77.8	77.8	61.1	22.2	33.3	0.0	11.1	22.2	27.8	
29 July	11.1	16.7		100.0	100.0	33.3	11.1	0.0	5.6	33.3	5.6	38.9	
6 August	38.9	22.2		94.4	100.0	94.4	72.2	33.3	27.8	16.7	33.3	66.7	
10 August	38.9	16.7		77.8	66.7	83.3	83.3	50.0	44.4	33.3	44.4	77.8	
11 August	27.8	16.7		94.4	94.4	72.2	50.0	27.8	27.8	44.4	22.2	72.2	
22 August	0.0	0.0		100.0	94.4	83.3	44.4	27.8	11.1	33.3	38.9	55.6	
Average	18.0	12.4		88.0	83.8	59.0	10.2	36.8	25.2	24.8	23.5	41.0	

Dates of observation	Time of observation (P. M.)														Average
	12:00 1:00	1:00 1:30	1:30 2:00	2:00 2:30	2:30 3:00	3:00 3:30		6:30 7:00	7:00 7:30	7:30 8:00	8:00 8:30	8:30 9:00	9:00 10:00	10:00 11:00	
15 June	66.7	16.7	16.7	50.0	50.0	16.7		94.4	94.4	77.8	50.0	11.1	11.1	0.0	47.2
16 June	55.6	44.4	61.1	27.8	22.2	11.1		83.3	94.4	88.9	55.6	0.0	5.6	0.0	41.9
24 June	33.3	27.8	22.2	11.1	33.3	11.1		72.2	94.4	50.0	33.3	0.0	0.0	0.0	36.6
2 July	0.0	11.1	27.8	22.2	0.0	0.0		100.0	100.0	61.1	72.2	72.2	11.1	16.7	32.4
10 July	22.2	38.9	33.3	33.3	44.4	33.3	Milk-	88.9	83.3	61.1	50.0	0.0	0.0	0.0	36.1
17 July	0.0	11.1	0.0	0.0	11.1	44.4	ing	72.2	72.2	94.4	44.4	5.6	0.0	0.0	28.0
23 July	38.9	33.3	44.4	50.0	61.1	27.8		83.3	77.8	61.1	66.7	0.0	0.0	0.0	39.4
28 July	33.3	16.7	11.1	33.3	38.9	16.7	Time	83.3	88.9	100.0	27.8	5.6	0.0	0.0	34.5
29 July	50.0	0.0	5.6	16.7	16.7	38.9		88.9	94.4	50.0	33.3	11.1	5.6	0.0	31.9
6 August	66.7	83.3	66.7	22.2	11.1	55.7		100.0	100.0	77.8	44.4	5.6	5.6	0.0	51.6
10 August	77.8	77.8	33.3	27.8	38.9	77.8		100.0	88.9	100.0	55.6	33.3	16.7	0.0	56.0
11 August	44.4	44.4	16.7	33.3	27.8	38.9		100.0	100.0	94.4	66.7	22.2	16.7	0.0	48.2
22 August	61.1	33.3	27.8	38.9	44.4	33.3		83.3	83.3	27.8	11.1	0.0	0.0	22.2	39.8
Average	42.3	33.8	28.2	28.2	30.8	31.2		88.5	90.2	72.7	47.0	12.8	5.6	3.0	40.3



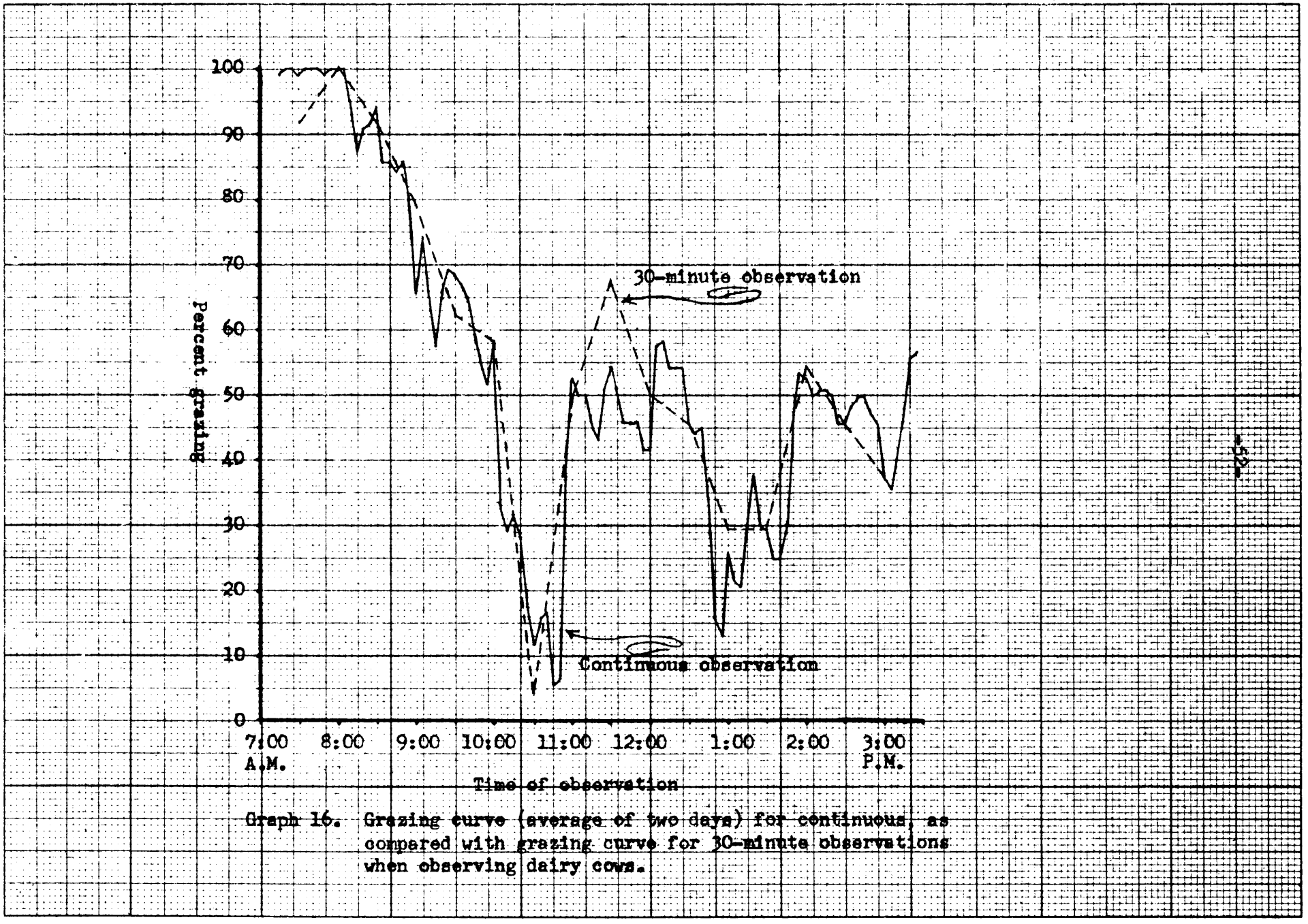
Graph 14. Grazing pattern of dairy cows within a day for three different days (average for all cows on all pasture treatments).



Graph 15. Grazing pattern of dairy cows within a day for two different days (average for all cows on all pasture treatments).

the evening milking. Graphs 14 and 15 are excellent illustrations of this difference.

In analysing the continuous observation data, only the times of day were significantly different at the five and one percent levels. When comparing the continuous data with 30-minute data graphically, the 30-minute grazing curve, in general, follows the trends of the continuous observation line (Graph 16).



Graph 16. Grazing curve (average of two days) for continuous, as compared with grazing curve for 30-minute observations when observing dairy cows.

EXPERIMENT III - SEQUENCE GRAZING EXPERIMENT

Procedure

The sequence experiment was established in 1952 to measure the quality and yield of herbage under continuous grazing and the twelve months' feed plan. Under the feed plan, the excess spring growth is saved for winter feed and more mixtures and acres are grazed during the summer months than in the spring. The following five mixtures were used:

Mixture	Use
a - Orchardgrass-bluegrass-white clover-ladino clover-red clover	For rotational grazing the entire season
b - Orchardgrass-lespedeza	For rotational grazing the entire season
c - Orchardgrass-ladino clover-red clover	First cut for silage, thereafter for rotational grazing
d - Alfalfa-orchardgrass-ladino clover	First cut for silage, then hay, hay, grazing
e - Alfalfa-orchardgrass	First cut for silage, then hay, hay, grazing

A 24-acre land area was divided into four replicated blocks of 6 acres each. Three acres of the six were designated permanent pasture and the remaining three acres were divided into five 0.6 acre lots.

The five mixtures were assigned at random to the five lots and mixture (a) was used in the continuously grazed lots. Water was available in all lots, but the availability of shade was not uniform.

Beef cows, heifers, and steers were used with 3 to 7 animals per lot, depending upon the availability of herbage.

In this thesis mixtures are not considered individually, but as part of a pasture management system; i.e., continuous or rotational grazing. A statistical analysis was made of the data using a split-split plot design (Table 13).

Results and Discussion

The grazing time for continuous and rotational pastures was similar (Table 13), being 6.7 and 6.5 hours respectively (Table 14).

The time spent grazing per day was different for each of the 5 test days. The time spent grazing daily tended to increase as the summer progressed (Table 14 and Graph 17). The difference between days could not be associated with temperature as the maximum daily temperature for the 5 test days was fairly constant whereas the amount of time spent grazing varied from 22.5 to 34.0 percent (Graph 17). A similar situation existed between minimum daily temperature and the grazing behavior. It is possible that the lower grazing time during the early season when compared with the late season may be associated with the more palatable herbage during June and early July. During August there was a drought period; hence the herbage may have been consumed slowly even though there was not an acute shortage of herbage.

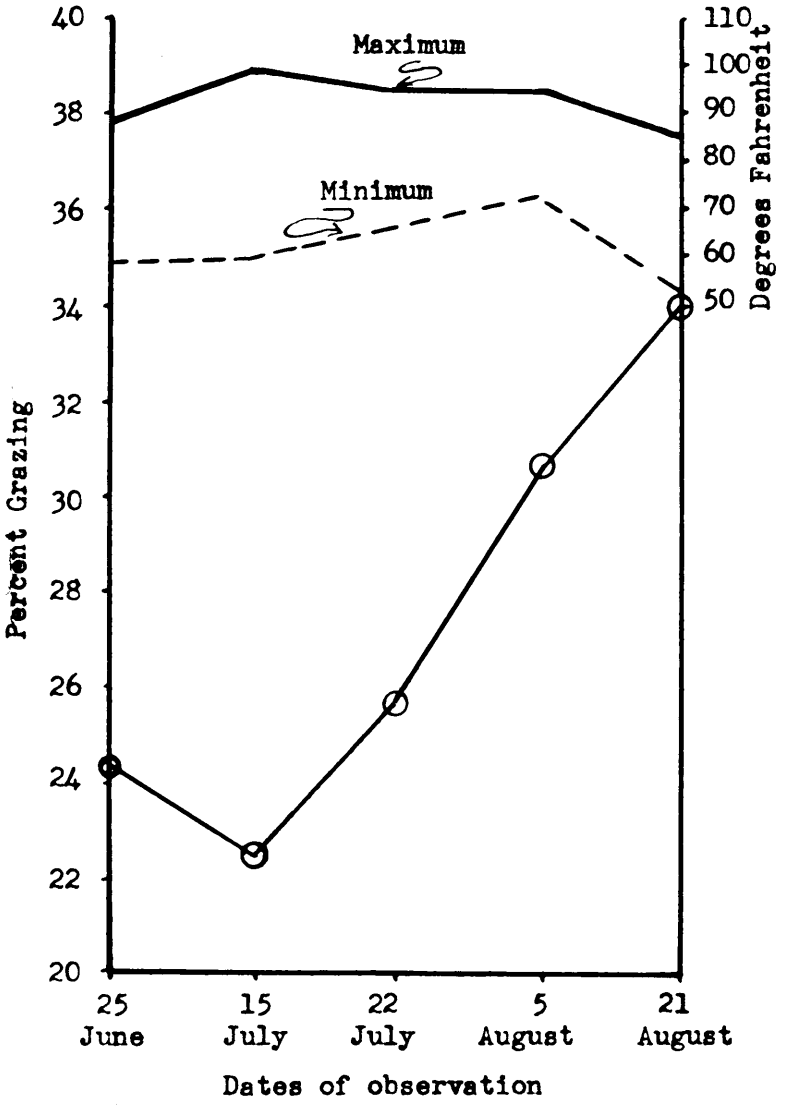
Table 13. Analysis of variance for sequence experiment.

Source	D/F	MS	F
Replications	3	571.087	1.542
Management	1	95.510	0.258
Error a	3	370.240	
Days	4	1962.533	6.969**
Days X Management	4	55.115	0.196
Error b	24	281.613	
Time	10	19595.708	47.083**
Time X Management	10	577.086	1.387
Time X Days	40	1451.837	3.489**
Time X Days X Management	40	460.414	1.106
Error c	300	416.195	
Total	439		

** Significant at 1 percent level.

Table 14. Grazing time of beef cattle on different days on rotational and continuous pastures.

Pasture Management	Date of observation					Average	
	25 June	15 July	22 July	5 August	21 August	Percent	Hours
Continuous	24.8	24.2	25.7	30.2	34.7	27.9	6.7
Rotational	23.8	20.9	26.0	30.9	33.4	27.0	6.5
Average	24.3	22.5	25.8	30.5	34.0	27.4	6.6



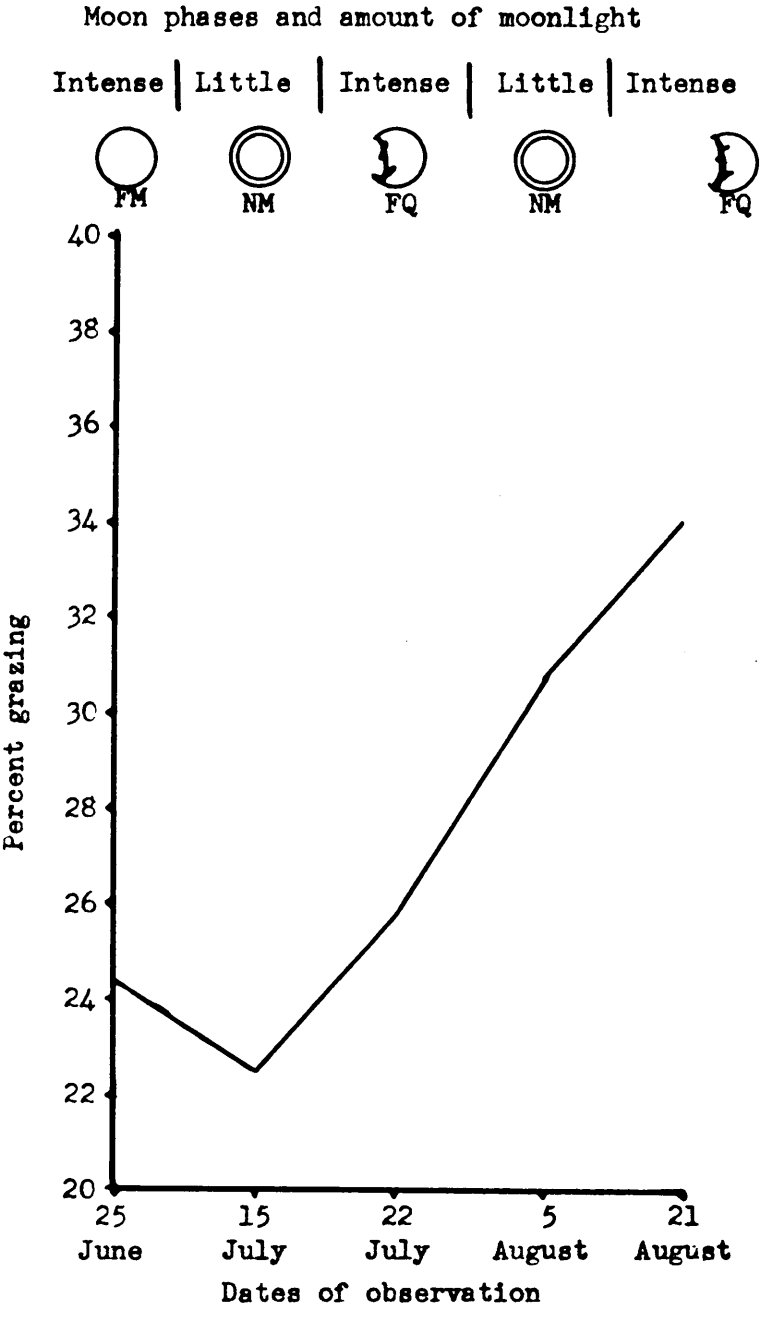
Graph 17. Grazing time of beef cattle (all pasture managements) as related to maximum and minimum daily temperatures.

Apparently the moon had no influence on the grazing behavior of the cattle in this experiment (Graph 18). During three intense moonlight periods, grazing activity ranged from low to high. During July 15, the grazing time was low and during August 5, it was high; both dates were during periods of low moonlight.

The amount of grazing at the various observation times during the day were different. The greatest grazing activity occurred during two major periods from 4:00 to 8:00 A. M., and from 4:00 to 8:00 P. M., (Table 15 and Graph 19). The evening peak was the largest with 70.9 percent of the animals grazing as compared to 55.2 percent for the morning period. The cattle tended to rest during mid-day and to bed down shortly after dark.

The animals grazing on rotational and continuous pastures grazed about the same amount at the various times during the day (Table 15). The differences were not enough to give a time and management interaction.

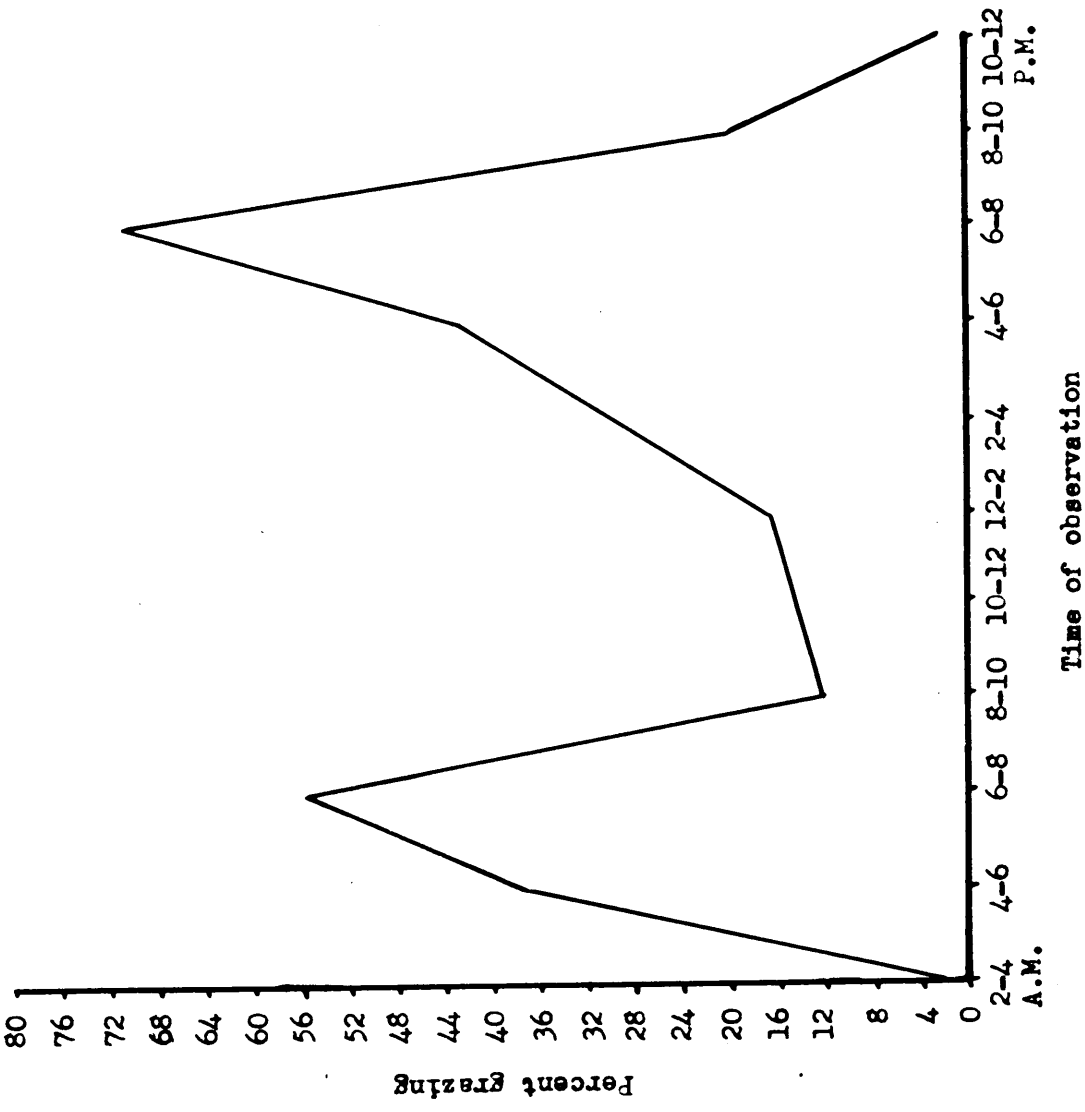
The amount of grazing for a given time varied for different days, hence the interaction of time and day was highly significant (Tables 13 and 16). Among the various days the grazing ranged from 22.3 to 45.9 percent during 4:00 to 6:00 A. M., and from 19.1 to 84.6 percent during 6:00 to 8:00 A. M. On August 21, 12.5 percent of the animals were grazing during 10:00 to 12:00 P. M., as compared with none during the other days. The time by day interaction is not explainable, but it may be attributed to differential responses of the animals to pasture conditions and climatic conditions.



Graph 18. Daily beef cattle grazing time as related to the moon.

Table 15. Time spent grazing on continuous and rotational pastures at different times during the day for the entire test period.

Pasture Management	Time of observation											
	A.M. 2-4	A.M. 4-6	A.M. 6-8	A.M. 8-10	A.M. 10-12	P.M. 12-2	P.M. 2-4	P.M. 4-6	P. M. 6-8	P. M. 8-10	P. M. 10-12	Average
Continuous	1.0	33.1	51.8	16.3	14.8	25.3	26.9	45.4	74.2	18.4	0.0	27.9
Rotational	0.0	40.6	58.7	8.4	14.4	8.4	32.2	40.1	67.7	21.6	5.0	27.0
Average	0.5	36.8	55.2	12.4	14.6	16.8	29.5	42.7	70.9	20.0	2.5	27.4



Graph 19. General grazing curve for all days and all pasture managements on the sequence experiment.

Table 16. Grazing time of beef cattle as related to time and dates of observation.

Dates of observation	Time of observation												Average
	A. M. 2-4	A. M. 4-6	A. M. 6-8	A. M. 8-10	A. M. 10-12	P. M. 12-2	P. M. 2-4	P. M. 4-6	P. M. 6-8	P. M. 8-10	P. M. 10-12		
25 June	0.0	45.9	19.1	13.6	17.7	12.5	21.8	24.4	63.8	48.8	0.0		24.3
15 July	0.0	33.9	47.8	6.6	12.5	15.6	12.4	43.1	57.8	18.3	0.0		22.5
22 July	0.0	45.5	55.9	8.3	11.0	33.4	11.0	30.6	69.5	19.1	0.0		25.8
5 August	2.5	36.6	68.8	10.8	6.3	0.0	50.4	64.9	85.0	8.6	0.0		33.6
21 August	0.0	22.3	84.6	22.5	25.4	22.5	50.1	50.6	78.6	5.1	12.5		37.4
Average	0.5	36.8	55.2	12.4	14.6	16.8	29.5	42.7	70.9	20.0	2.5		27.4

GENERAL DISCUSSION

The technique employed in this investigation is subject to criticism since the cattle obviously did not always behave the same throughout a time interval as they did at the start of the time interval during the observations. The data for periods of intense grazing were more precise estimates of grazing behavior than those for periods of less intense grazing because there was more animal variability during the latter periods. The estimates were poorest for the wider intervals and for the periods of greatest animal variation. However, the continuous data with dairy cows gave daily patterns similar to those made at intervals. This indicates that the data taken at selected time intervals give a rather reliable trend of the grazing activity. Since this investigation was conducted to get trends for a large number of variables rather than extremely detailed data, the technique used may be suitable. The method employed is useful for survey information that is to be the basis for future planning of grazing behavior experiments.

The results showed significant differences for day to day behavior. The day to day differences in behavior did not seem to be associated with moon phase and light or management of the animals. The day to day variance was associated with temperature on the dairy grazing experiment. These experiments were nutritional experiments that could not be changed to make grazing behavior the primary objective. Since the pasture conditions such as amount of herbage and

succulence differed for the different pasture mixtures during days observed, it is possible that these factors alone could cause some of the day to day variation. To overcome this situation, the pasture conditions of the experiment must be the same from one day to the next to obtain accurate day to day data. It would be very desirable to obtain continuous and non-continuous data on another experiment where the pasture conditions, especially the availability of herbage could be carefully controlled. It would be desirable to have other environmental conditions such as shade, water, and age of animals be essentially the same.

There was no significant difference between mixtures as indicated by the analysis of variance. The amount of herbage for mixtures was not equal within or among the days. These differences may have averaged out in such a manner that any differences in mixtures were confounded. It would be desirable to establish an experiment where the amount of herbage available for all mixtures within a day is constant.

In the case of the dairy grazing experiment, the grazing behavior was associated with temperature but no such relationship could be established with beef cattle. In view of the three experiments reported, the odds are two to one against temperature effect on grazing habits of cattle. The literature reviewed indicates that temperature effects dairy cattle grazing behavior but there were no reports on temperature data for beef cattle. It may well be that dairy cattle are more sensitive to temperature changes than beef cattle. Perhaps the data

taken at closer intervals for dairy were more sensitive to changes in grazing behavior than in experiments with beef cattle. It would be desirable to check this factor more closely by recording the temperature at the time of each observation. Generally, beef cattle gains go down during mid-summer. This might be associated with the high temperatures that occur during this period of the grazing season. The cattle may not graze as much as during the cooler part of the grazing season so consequently gains are less.

The differences in time of grazing within a day are very large. The differences are so large that they should be accepted as real differences. It was noted that a general grazing pattern was similar for all days but that the pattern shifted some from day to day. Perhaps more frequent observations in conjunction with frequent temperature observations would have helped in obtaining a better knowledge of the daily grazing pattern.

The data indicated that the moon phase and the intensity of moonlight do not influence the average time spent grazing per day. It would be of interest to follow the grazing pattern during days when the moonlight intensity is high and low to see if the grazing pattern is shifted within the day due to this factor.

The summer of 1953 was not a normal or average summer for Northern Virginia. The maximum and minimum daily temperatures were higher and the rainfall was considerably less than the average. It was especially hot and dry during the month of August. The succulence and quantity of herbage available to the cattle was reduced. Some pasture plants are

more drought and heat resistant than others, therefore, some lots provided more herbage.

When studying carrying capacity and animal gains per acre, the cattle were moved to new pastures when in the judgement of the experimenter or his helpers, the mixtures and or species had been grazed to a point where there was an herbage shortage. A departure from the normal grazing pattern might be useful in estimating grazing intensity more precisely than the usual estimation of herbage supply available. If a general grazing pattern can be established, it might be possible to associate grazing during unexpected times with over grazing or herbage shortage.

It was planned to obtain data on individual animals in these experiments. Because of great difficulties in finding methods of identification of animals both in the daytime and at night, this procedure was dropped in favor of group data for beef cattle. Disks carrying the animal numbers were put on neck chains but the numbers were difficult to see at a distance even when using binoculars. A band of white house paint was painted around the mid-section of the test steers on the beef grazing experiment. The animals ate and rubbed most of the paint off and the remainder was washed off by the rain. The dairy test cows were identified by different colored pieces of cloth attached to their neck chains. This procedure was not entirely satisfactory for the colors became wet, faded, and soiled thus making them difficult to identify at any distance. The cloth could not be seen if the cows were looking away from the observer or very clearly at night, especially

when the observer remained away from the animals so as not to disturb them. Some sort of luminous devices or paint probably would be more satisfactory than the markings tried.

Some dairy workers refer to grazing at night in their reports. This is a misleading statment for night grazing generally refers to all grazing starting immediately following the evening milking until one hour before daylight.

SUMMARY AND CONCLUSIONS

Grazing behavior data were recorded for beef and dairy cattle on three established nutritional experiments at the Northern Virginia Pasture Research Station, Middleburg, Virginia during 33 different days in June, July, and August, 1953. The time spent grazing was recorded for different pasture mixtures and/or species, for different methods of rotational grazing, for continuous grazing of one mixture as compared to rotational grazing, and for dairy cows receiving different grain supplements.

The data were taken at various intervals throughout a twenty-hour day with the exception of two days when continuous data were recorded for dairy cows. The calculations are based upon the assumption that the behavior at the time of observation is representative of the interval of time between observations; hence the values reported are apparent figures. A statistical analysis was made on all data.

From the data obtained, the conclusions are:

1. The time spent grazing on six pasture mixtures did not differ significantly when grazed by beef cattle during 15 days in a three-month period.
2. The total time spent grazing per day differed significantly from day to day.
3. Maximum and minimum daily temperatures did not influence the grazing behavior of beef cattle but influenced the grazing behavior of dairy cows.

4. The intensity of moonlight and moon phase could not be associated with the total time spent grazing.
5. The amount of time spent grazing per day varied less between consecutive days than between separated days.
6. Beef cattle grazed a daily pattern of high grazing activity at approximately 4:00 to 8:00 A. M., and at 4:00 to 8:00 P. M., with medium grazing at 10:00 to 12:00 A. M.
7. When considering an average for all mixtures during all days, beef cattle grazed more from 4:00 to 8:00 P. M., than any other time during the day.
8. Dairy cattle grazed heavily following return to the pasture in the morning and evening with a mid-day period of moderate grazing.
9. There was no significant difference in the amount of grazing per day with different pasture managements or mixtures with dairy cattle.
10. There was no significant difference in daily grazing time by dairy cows fed various amounts of grain supplements.
11. Taking observations of grazing behavior at one-half hour intervals gave a rather reliable trend of the grazing behavior and would be useful for survey work preceding a detailed continuous experiment.
13. Daily grazing did not differ significantly for beef cattle when grazing rotational and continuous pastures.

13. A daily grazing pattern may be a useful index for the amount of herbage and the intensity of grazing on experimental lots, thereby eliminating the errors in judgment and prejudice of experimenters.

BIBLIOGRAPHY

1. Blaser, R. E., et al. The Third Annual School, Northern Virginia Pasture Research Station, Middleburg, Virginia, (mimeographed report). 1953.

2. Blaser, R. E., et al. The Fourth Annual School, Northern Virginia Pasture Research Station, Middleburg, Virginia, (mimeographed report). 1954.

3. Bruce-Levey, E. Correlation of pasture type and stage of growth with intensity of feed-flavour. N. Z. Jour. Agr., 50:135-147. 1935.

4. Castle, M. E., Foot, A. S., and Halley, R. J. Some observations on the behavior of dairy cattle with particular reference to grazing. Jour. Dairy Res., 17:215-229. 1950.

5. Cory, V. L. Texas Agr. Exp. Sta. Bul. 367. 1927.

6. Duncan, D. B. Multiple range and multiple F tests. Biometrics. To be published Dec., 1954 or March, 1955.

7. Fisher, Howard Lee. The grazing habits of lactating dairy cows under certain environmental conditions. M. S. Thesis, Virginia Polytechnic Institute, Blacksburg, Virginia. April, 1954.

8. Giöbel, G., and Lindbom, E. The intensity of grazing of milking cows at different times of day and night. Nutr. Abstr. Rev., 3:1173.1933-34.

9. Hein, M. A. Effect of method and rate of grazing on beef production and plant population of pastures at Beltsville, Md. U. S. D. A. Agr. Tech. Bul., 538. 1937.

10. Hein, M. A. Grazing time of beef steers on permanent pastures. Jour.Amer. Soc. Agron., 27:675-679. 1935.

11. Hodgson, R. E. The influence of pasture management upon the grazing habits of dairy cattle. U. S. D. A. Jour. Agr. Res., 47:417-424. 1933.

12. Johnstone-Wallace, D. B., and Kennedy, K. Grazing management practices and their relationship to the behavior and grazing habits of cattle. Jour. Agr. Sci., 34:190-197. 1944.

13. Kennedy, W. K. The grazing habits of cattle on the composition, consumption, and utilization of pasture herbage. M. S. A. Thesis, Cornell Univ., Ithaca, N. Y. 1941.

14. Moseley, T. W., Stuart, D., and Graves, R. R. Dairy work at the Huntley Field Station, Huntley, Mont. U. S. D. A. Agr. Tech. Bul. 116. 1929.

15. Shepperd, J. H. N. Dak. Agr. Exp. Sta. Bul. 211. 1927.

16. Waite, R., Macdonald, W. B., and Holmes, W. Studies in grazing management. III. The behavior of dairy cows grazed under the close-folding and rotational systems of management. Jour. Agr. Sci. 41:163-173. Jan.-April, 1951.

The vita has been removed from the scanned document