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Comparison of Piper Sudangrass and Starr pearlmillet fed to lactating dairy cows

Joseph William Wrather

To the Graduate Council:

I am submitting herewith a thesis written by Joseph William Wrather entitled "Comparison of Piper Sudangrass and Starr pearlmillet fed to lactating dairy cows." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.

Louis J. Boyd, Major Professor

We have read this thesis and recommend its acceptance:

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

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

July 3, 1958

To the Graduate Council:

I am submitting herewith a thesis written by Joseph William Wrather entitled "Comparison of Piper Sudangrass and Starr Pearlmillet Fed to Lactating Dairy Cows." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Dairying.

Louis J. Boyd
Major Professor

We have read this thesis
and recommend its acceptance:

C. E. Wylie

I. V. Hold

Accepted for the Council:

Dale Wantling
Dean of the Graduate School

COMPARISON OF PIPER SUDANGRASS AND STARR PEARLMILLET FED TO LACTATING DAIRY COWS

A THESIS

Submitted to
The Graduate Council
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

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by
Joseph William Wrather

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INTRODUCTION

Morrison (20) stated that providing good pasture is the cheapest way of producing milk. When cows are given access to good pasture they get more of the nutrients required for milk production than they get from barn fed hay or good silages. Good pastures are high in digestible nutrients, proteins, minerals, and vitamins which are needed by the cow.

Because of the summer droughts Tennessee dairymen should provide a supplemental source of pasture to furnish adequate grazing for their dairy cows during the mid-summer. Supplemental pasture tends to maintain milk production at a high level and in addition it permits proper management of orchardgrass and Ladino clover or tall fescue and Ladino clover pastures.

Sudangrass and pearlmillet are summer annuals that continue to grow during hot, dry, summer weather better than most forage crops. They produce their maximum growth at a time when permanent pastures are likely to be least productive. They are palatable and nutritious grasses and can be used for silage or hay as well as pasture. Due to these characteristics they fit well into the forage program on a dairy farm.

The importance of Sudangrass as a summer supple-

mental feed is recognized. However, pearlmillet is relatively new in Tennessee and little information is available as to its feeding value. This study was made to compare the feeding value of Starr pearlmillet and Piper Sudangrass. If the feeding value of pearlmillet is equal to that of Sudangrass, dairymen could take advantage of the higher yields and the greater disease resistance of the pearlmillets (9, 24).

REVIEW OF LITERATURE

A search of the literature was made to determine the value of pastures for dairy cows, the value of summer pastures, and the relative feeding value of Sudangrass and pearlmillet for milk production.

Value of Pastures for Dairy Cows

Semple and Woodward (26) made a study of the nutritive requirements for the production of market milk. They found in a survey of dairy farms in southern Indiana that pastures furnished nearly one-third of the annual sustenance for the cows. On these same farms the pasture cost was only one-seventh of the total feed cost. They also found that the farms that had half of the farm area in pasture and half in crops returned more profit than those that had one-third in pasture and two-thirds in crops. Thirty-six per cent of the total feed on these dairy farms came from pasture. The nutrients from pasture cost only one-fourth as much as the nutrients from the harvested crops.

Foley (8) made a study to determine the most economical feed for summer rations. He found that the most economical ration for the summer months was an abundance of palatable nutritious pasture with mixed hay.

By use of this ration he got a wide grain to milk ratio.

Wylie and Neel (31) found that under Tennessee conditions dairy cows produced more economically on a year around pasture and limited grain than on full grain feeding and limited pasture.

Hazlewood (13) also showed that under Tennessee conditions cows declining in milk production at the first of June increased in production when given access to supplemental summer pasture. The cows attained a higher level of milk production in July than they had produced in June on permanent pasture.

Sudangrass

Jones, Lewis, and Dodd (16), in an extension publication, reported that Sudangrass was brought to the United States in 1909 from Africa. It is a vigorous growing, dependable, summer annual grass. Mulvey (21) stated that it is a member of the sorghum family, is a rapid growing plant, competes readily with weeds, and attains a height of five or more feet under reasonable soil and weather conditions. The plants are upright in habit of growth and are quite leafy. The stems of mature plants are rather coarse being about one-half the diameter of solid seeded sorghum.

Vinall (30) stated that Sudangrass is admirably

suited for use as a soilage crop, since it makes a large yield and is very palatable in the green state. By this method of feeding, in the south, where the rainfall is adequate or where irrigation is possible, a small area can be made to support several animals. Schoth and Rampton (25) found that under this system, a forage crop on a given area of land usually produced more green feed than if the crop was pastured, but the labor required was greater. A soilage crop should be cut daily and only in amounts sufficient for the day. Fresh green forage spoils quickly when piled or allowed to stand.

Schoth and Rampton (25) recommended Sudangrass because of its ability to produce a large amount of forage within a short time after seeding. For this reason, it fits well into a short rotation and is quite satisfactory as a catch crop. These workers also stated that under favorable conditions one acre will support two to three animal units during the pasture season (60 to 75 days).

Gaessler and McCandlish (10) made analyses of Sudangrass at different stages of maturity. They found there was a decrease in the protein and an increase in crude fiber when Sudangrass started heading, thus indicating the forage should be cut before heading for a high level of nutritional value.

Pearlmillet

Pearlmillet is the most widely used temporary summer pasture crop in the southeastern states and is also used in the south (20).

Hoveland and McCloud (15) recommended that the Starr variety of pearlmillet be 30 in. tall before grazing began and be grazed down to a stubble height of 10 to 18 in. For silage or green feed they found that Starr pearlmillet should be cut when it is 4 or 5 ft. tall. Highest total yield was obtained when the plants were 54 in. tall and cut down to 4 in.; however at this cutting the plants were lowest in protein.

Cathcart (6) found that pearlmillet was satisfactory as a silage crop as well as a pasture, but the results showed that pearlmillet yielded 740.58 lb. of total digestible nutrients (TDN) per acre when grazed and only 518.50 lb. of TDN as silage. Under the conditions used, pearlmillet produced 42.9% more nutrients per acre when grazed than when harvested as silage.

Yields of Sudangrass and Millet

Fortmann et al. (9) used plots that were 5 by 20 ft. to compare the yield of Sudangrass and millet. They used Sweet and Tift Sudangrass and pearl and German millet.

Pearlmillet yielded 8,635 lb. of dry matter and 618 lb. of protein per acre as the highest yielding millet whereas the highest yielding Sudangrass was 6,098 lb. of dry matter and 526 lb. of protein per acre.

Crowder, Parker, and Elrod (7) made a study of the different varieties of Sudangrass and pearlmillet. They compared Tift, Common, and Sweet Sudangrass and found that Tift had a pithy, non-sweet stem which tended to tiller and developed more side branches than Common. It was also more disease resistant and later in maturity. Sweet Sudangrass was not as productive as Tift and not quite as disease resistant. The millets tested were Browntop, Foxtail, German, Starr pearlmillet, and Common pearlmillet. They found that Starr pearlmillet was a lower growing plant, had broader leaves, and was more disease resistant than Common pearlmillet. Starr pearlmillet also gave higher yields than any of the other millets tested. The protein content of the Sudangrasses and the millets varied with fertilizer treatments, particularly nitrogen.

Underwood et al. (29) calculated the yields of Tift Sudangrass and Starr pearlmillet. They found the TDN yield from Sudangrass was 1,358 lb. per acre and 1,293 lb. from pearlmillet. The dry matter was also measured but the differences in yields of dry matter and TDN were not significant.

Roark et al. (24) compared the yield of Tift Sudangrass and pearlmillet by using lactating dairy cows. The cows obtained 2,056 lb. of TDN per acre from pearlmillet and only 1,480 lb. of TDN per acre from Sudangrass.

Feeding Value of Sudangrass and Millet

Olson and Evans (23) compared sweetclover, alfalfa, and Sudangrass as pasture forages for lactating cows. They compared palatability of the three forages and milk production, butterfat, and body weight gains, produced from an acre of each forage. Results showed that the Sudangrass pasture was the most palatable followed by alfalfa and sweetclover. The cows lost weight on the sweetclover plots. The length of pasture season was 67 days for sweetclover and alfalfa, but only 51 days for Sudangrass. The highest milk and butterfat yield per acre was obtained from sweetclover, alfalfa, and Sudangrass in that order.

Henke and Goo (14) in Hawaii, compared Sudangrass and Napiergrass when fed to lactating cows. The cows were kept on a dry lot, and the soilage technique was used to feed the forages. Concentrate mixture was fed according to milk production.

Average daily milk production was 27.6 lb. for the Sudangrass-fed group and 25.4 lb. for the Napiergrass-fed group. Average daily consumption of Napiergrass was 54.2 lb.

and the consumption of Sudangrass was 58.2 lb. These amounts, with the concentrates, furnished the required protein and total nutrients as prescribed by Morrison's standards (20). Analyses of the two grasses showed Sudangrass to be higher than Napiergrass in protein, nitrogen-free-extract, and TDN.

Neel (22) tested the feeding value of Sudangrass at the Middle Tennessee Experiment Station in 1931 and 1932. Dairy cows that were previously on a pasture of bluegrass and clover were used. When they were turned on Sudangrass pasture, milk production increased 15 to 20 per cent.

The feeding value of pearlmillet was measured by Marshall et al. (19). Lactating dairy cows began grazing the millet when it was 14 to 22 in. tall and remained on the pasture the full time except while being milked. During milking they were fed a 16% concentrate ration at the rate of 1 lb. for each 3.5 lb. of milk. The cows derived 60.5% of their total TDN intake from the millet. This was adequate to support the requirements for body maintenance plus a daily production of 10 lb. of 4% fat corrected milk (FCM). Persistancy of milk production was good, and the cows had only a very small change in body weight.

Burton and Southwell (3) compared the palatability

of Bermudagrass, pearlmillet, and Sudangrass. This was done by sowing plots of each of the grasses and fencing them all into the same field. After the grasses reached grazing height, beef cattle were turned into the fenced area and the amount of each forage grazed was the means of determining palatability.

Their results showed Sudangrass to be the most palatable. Several strains of pearlmillet were used, and it was found that the finest stemmed strain was the least palatable.

Underwood et al. (29) compared Tift Sudangrass and Starr pearlmillet when fed to lactating dairy cows. They used two equalized groups of Jersey and Holstein cows. Rotational grazing was used and after each 3 weeks period the groups of cows were changed to the other species of grass. Both groups were fed concentrates according to milk production.

The average daily 4% FCM production was 22.2 and 21.8 lb. for the cows grazing Sudangrass and pearlmillet, respectively. The cows on Sudangrass gained an average of 1.1 lb. per cow daily which was significantly more than the 0.7 lb. daily gain per cow while on pearlmillet. They found that the Sudangrass was slightly more digestible than pearlmillet as measured by the Chromogen and Chromic Oxide methods.

Roark et al. (24) compared the feeding value of Tift Sudangrass and pearlmillet when fed to dairy cows. They obtained 2,174 lb. of 4% FCM per acre from the cows on Sudangrass and 3,246 lb. of 4% FCM per acre from the cows on pearlmillet. They obtained the highest gain in body weight from Sudangrass.

Soilage as a Method of Feeding Forage

The value of the soilage technique has been demonstrated, and by its use soilage crops have stimulated milk production. Gillette, McCandlish, and Kildee (12) stated that through the use of soilage the production of digestible nutrients is increased from three to five times.

In experiments conducted by Carlyle, Danks, and Morton (5) it was shown that cows that were fed soilage crops maintained milk yield at a higher level than the cows on pasture. However, cows that were fed forage by the soilage technique were not in the same herd nor on the same grass as the cows given access to pasture. These investigators reported a daily consumption of 75 to 100 lb. of green forage per cow. They stated that the acreage required per cow may be reduced at least one-half by using the soilage method rather than to pasture the grass.

Lane (18) made a study of several forages for use as soilage crops. One of the most promising forages tested

was pearlmillet. He obtained an average of 12 tons of green forage per acre from pearlmillet when cut and fed as soilage. The daily milk yield was 18.6 lb. per cow while on the soilage, whereas, the previous yield had been only 16.6 lb. per cow when given access to pasture.

Brandt and Ewalt (2) made a 5 year study to compare the production of pasture under grazing and clipping management. The pasture was made up of mixed grass and Ladino clover. Rotational grazing was used and under this system each plot was grazed 13 to 14 times during the season.

Dairy cows were used to measure the production of the grazed portion. The average daily production of milk was 44.1 lb. and 1.45 lb. of butterfat per cow. The TDN was calculated by the animal requirement method for the grass that was grazed. The TDN from the grass that was clipped was calculated from the chemical composition. A comparison of the yields showed the clipped grass yielded 5% more TDN per acre than the grazed grass. The difference of 5% was obtained under the conditions in which the barn was located adjacent to the pastures. In a previous study by the same workers, the cows had to walk four miles daily to and from pasture and the difference was 20 to 25% in favor of the clip method.

Gillette, McCandlish, and Kildee (12) found that the

soilage technique required more labor than to pasture the grass and the soilage crop had to be harvested in all kinds of weather. They stated that the specific conditions of the dairyman determined the practicability of using soilage crops.

In the search of literature no data were found comparing Piper Sudangrass and Starr pearlmillet. For many years, Sudangrass has been used by some Tennessee dairymen as a temporary summer pasture. Piper Sudangrass is one of the varieties of Sudangrass currently recommended for Tennessee (28). Most of the literature reviewed agreed that pearlmillet was the higher yielder and more disease resistant (9,24). This study was made to obtain information on the feeding value of the Starr variety of pearlmillet and the Piper variety of Sudangrass which can be used by Tennessee dairymen in selecting the best supplemental summer pasture.

METHOD OF PROCEDURE

This study was designed to compare the feeding value of the Piper variety of Sudangrass, Sorghum Vulgare, var. sudanensis piper, and the Starr variety of pearl-millet, Pennisetum glaucum when fed to lactating cows. The lactating cows used in this study were selected from the University of Tennessee Dairy Herd. The crops were grown on the University of Tennessee Dairy farm. The procedure used is explained below.

Hereafter, for simplification, Starr pearlmillet will be referred to as millet and Piper Sudangrass as Sudangrass.

Date and Method of Establishment of the Sudangrass and Millet. Two fields which had been heavily manured and were approximately uniform in fertility and other soil characteristics were used to grow the two grasses. Field one was a fertile river bottom containing 10 acres of which one-half was sown with Sudangrass and the other half with millet. On May 18, 1957, the field was seeded by drill at the rate of 30 lb. per acre with Sudangrass and 20 lb. with millet. Fifty pounds of 60% muriate of potash, 50 lb. of 48% phosphate, and 150 lb. of 33.5% ammonium nitrate were applied per acre at the time of seeding. Irrigation was used for establishment of seeding and again after the first clipping.

Field two contained 8 acres and was adjacent to field one. It was seeded June 7, 1957, at the same rate of seeding and fertilization as field one with half in Sudangrass and half in millet. This field was irrigated for establishment of the seeding only.

Method of Harvesting and Feeding the Forages. On June 14, 1957, 26 days after seeding, the initial harvest began on field one. At this time the Sudangrass was approximately 35 in. in height and the millet was approximately 20 in. Sudangrass only was clipped for 5 days and the millet clipping began on June 17, 1957.

Initially the forages were harvested twice daily, but due to the shortage of labor and equipment the harvesting was changed to once per day. Each forage was harvested in the late afternoon. One-half of each forage was fed shortly after chopping and the remaining portion was fed the following morning. The forages were harvested with a field chopper and blown into a truck that was driven beside the chopper. The truck bed was partitioned in the center to keep the Sudangrass and millet separated.

On July 9, 1957, which was 31 days after seeding, the forages in field two were ready to begin chopping. The remainder of the forages in field one was cut, weighed, and ensiled. On July 28, 1957, the second growth of field one was ready for chopping and the remaining forages in field

two were ensiled. These two seedings and these mangement practices were used to insure sufficient quantities of green forage at the desired stage of maturity.

Pairing of the Cows. There were 10 pairs of Holstein and 7 pairs of Jersey cows used in the experiment. The animals were divided into two groups as comparable as possible with regard to milk production, body weight, age, stage of lactation, stage of gestation, and breed. The above information on the paired cows is shown in Appendix F and G.

Feeding and Care of the Cows. The soilage technique was used to feed the two forages. Both groups of cows were kept in dry lots and a loafing shed except during milking.

Every afternoon, shortly after chopping, a portion of each forage was forked into feed carts and weighed on platform scales. It was then fed to the cows in a concrete feed manger located in a loafing shed. The next morning the refused forages were weighed back and fed to cows not on the experiment. The remainder of each grass on the truck was then weighed and fed to the respective group of experimental cows. Individual consumption of green forages was not measured. All roughage consumption was measured on the group basis.

Starting on June 17, 1957, one group of cows was fed Sudangrass, and the other group was fed millet. On July 15,

1957, which was 28 days after the first experimental period had begun, the groups were reversed so that the group that had been receiving Sudangrass was changed to millet, and the group that had been receiving millet was changed to Sudangrass for another 28 days.

The Holstein cows were fed grain at the rate of 1 lb. for each 4 lb. of milk produced and Jerseys received 1 lb. of grain for each 3 lb. of milk produced. The grain mixture was made up of 1 part corn, 2 parts oats, and 1 part cottonseed meal. Both cows in each pair were fed the same amount of grain throughout each experimental period. The cows were so closely paired on the basis of milk production to make this feasible. The grain feeding rate for the first 28 days of the experimental period was based on the milk production of the pre-experimental period. An adjustment in grain feeding for each pair, based on milk production during the first period, was made at the beginning of the second 28 days of the experiment. Three pounds of hay per cow were fed daily. The hay was a mixture of alfalfa, oats, and Johnsongrass. The cows had constant access to water, salt, and a mineral mixture of defluorinated phosphate.

The pre-experimental period lasted from June 3, 1957, to June 17, 1957. The paired cows were on permanent pasture 9 days and chopped Sudangrass in dry lot 5 days of the 2 weeks prior to the first experimental period. The post-experimental

period lasted from August 12, 1957, through August 23, 1957. During this period both groups remained in dry lot on Sudangrass. The pre-experimental and post-experimental periods were included to help determine if any observed difference in milk production during the experiment could have been due to the grouping of the cows or to the forages fed.

Milk Production, Butterfat, Total Solids, and Body Weight. The cows were milked twice daily and their production recorded at each milking. The pounds of milk and butterfat produced were converted to 4% FCM (11). A sample of milk was obtained from each cow weekly by mixing a sample of the nights milk and mornings milk. The milk samples were tested for percentage butterfat and total solids. The butterfat tests were made by the Babcock method (1).

The total solids tests (1) were made by weighing a 2.5 to 3 g. sample into a flat-bottomed aluminum foil dish. The milk samples were exposed to room temperature overnight. Then they were placed into a vacuum oven at 100°C for one hour. They were cooled in a desiccator and weighed. The weight of the residue was used to calculate per cent total solids in the original milk.

The cows were weighed individually each week on the same day of the week, the same time of day, and by the same persons each time. The weekly observed body weights were smoothed by calculating the three sample running average.

This was done to minimize the fluctuations in body weights from week to week.

Satistical significance of differences in milk production, 4% FCM, body weight, butterfat, and total solids was determined by analysis of variance (27).

Composition and Yield of Forages. Three days per week a sample of each forage was obtained by grasping a handful about 15 in. below the surface at 5 different positions in the load of grass. The samples were weighed at the laboratory and placed in an oven to dry at 60°C. They were taken out after 15 to 20 hours or after drying and allowed to remain in the laboratory at room temperature until ground. They were then weighed and ground in a Wiley mill. A portion from each individual sample was mixed to obtain a weekly composite sample. Chemical analyses were made on the composite samples for protein, crude fiber, ether extract, ash, and moisture (1).

Samples of the concentrates and hay fed were taken once during each 28 day experimental period. The same chemical analyses were made on these samples as were made on the green forages.

The percentages of TDN in the concentrate mixture and the hay were calculated by using digestion coefficients given in Morrison's (20). The amount of TDN obtained by the cows from the forage was calculated by the animal

requirement method (17). By the use of this method the respective forages were credited with 3.53 lb. of TDN for each lb. of gain in weight and debited 2.73 lb. for each lb. lost in weight. The requirements for milk production and body maintenance were obtained from Morrison's standards (20).

The yield from each field was measured by weighing all the forages fed as soilage plus forage that was put in the silo.

RESULTS

Milk Production and 4% FCM Produced. The daily 4% FCM produced per cow during the entire experiment was 28.5 lb. for the group fed Sudangrass and 29.1 lb. for the group that was fed millet. During the first 28 days of the experimental period the daily 4% FCM yield for the cows receiving Sudangrass was 30.4 lb. per cow and the yield for the cows receiving millet was 29.8 lb. per cow. During the second 28 days of the experimental period the daily average yield of 4% FCM for the group that was fed Sudangrass was 26.7 lb. and 28.4 lb. for the cows that were fed millet. The average daily production of 4% FCM during each experimental period is shown in Table I. Figure 1 shows the average daily milk production for both groups of cows. The average daily milk production for the cows of each breed is shown in Figure 2. The average daily milk production for each pair of cows is shown in Appendix A.

Statistical analysis of the milk production data showed no difference between the two forages at the 5% level of probability. Likewise, there was no significant difference between the two forages in the amount of 4% FCM produced by the experimental cows. The analysis of the data on 4% FCM is shown in Appendix B. As expected, there was a significant difference between weeks, periods, and the cows

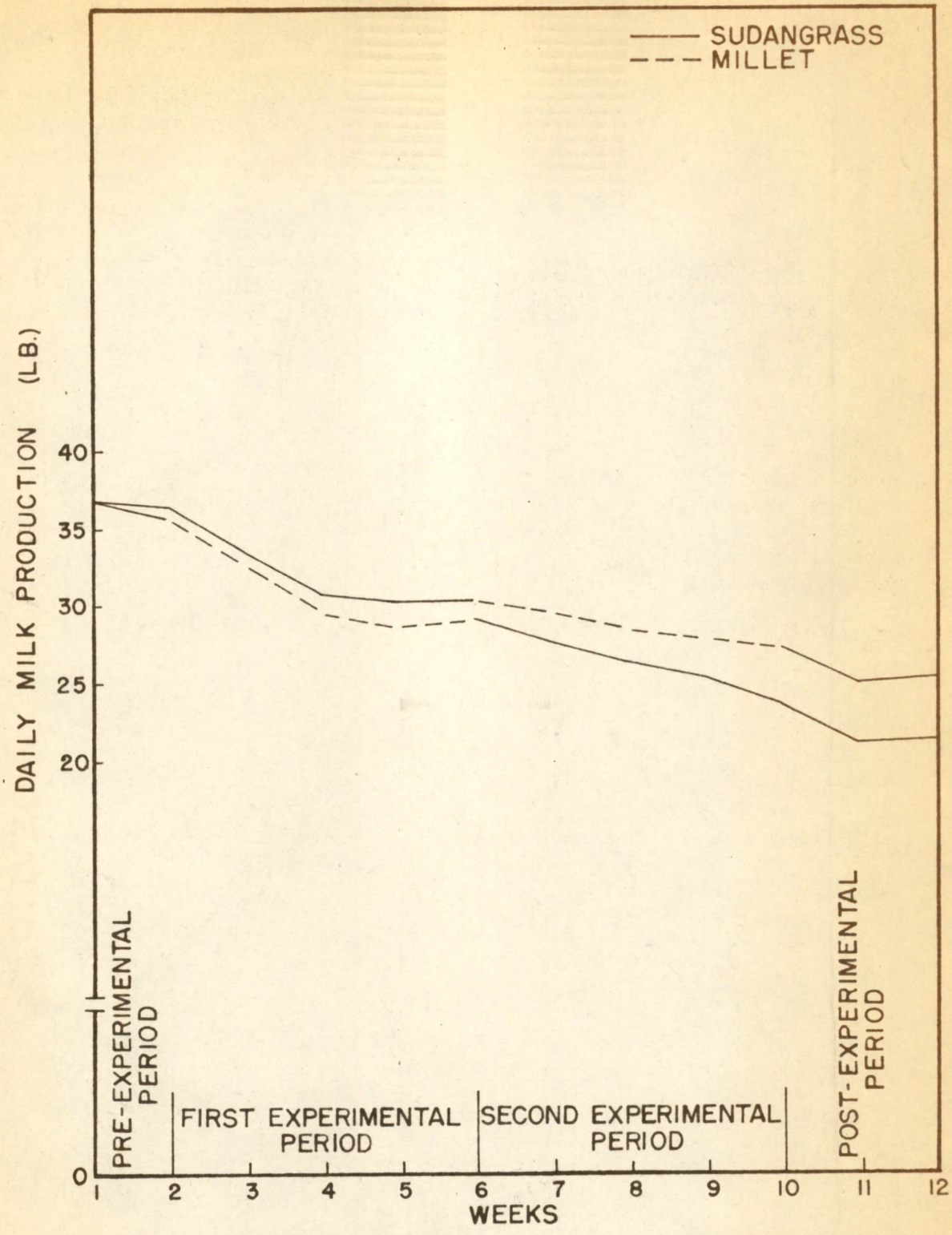

FIGURE 1. AVERAGE DAILY MILK PRODUCTION OF COWS FED SUDANGRASS AND MILLET.

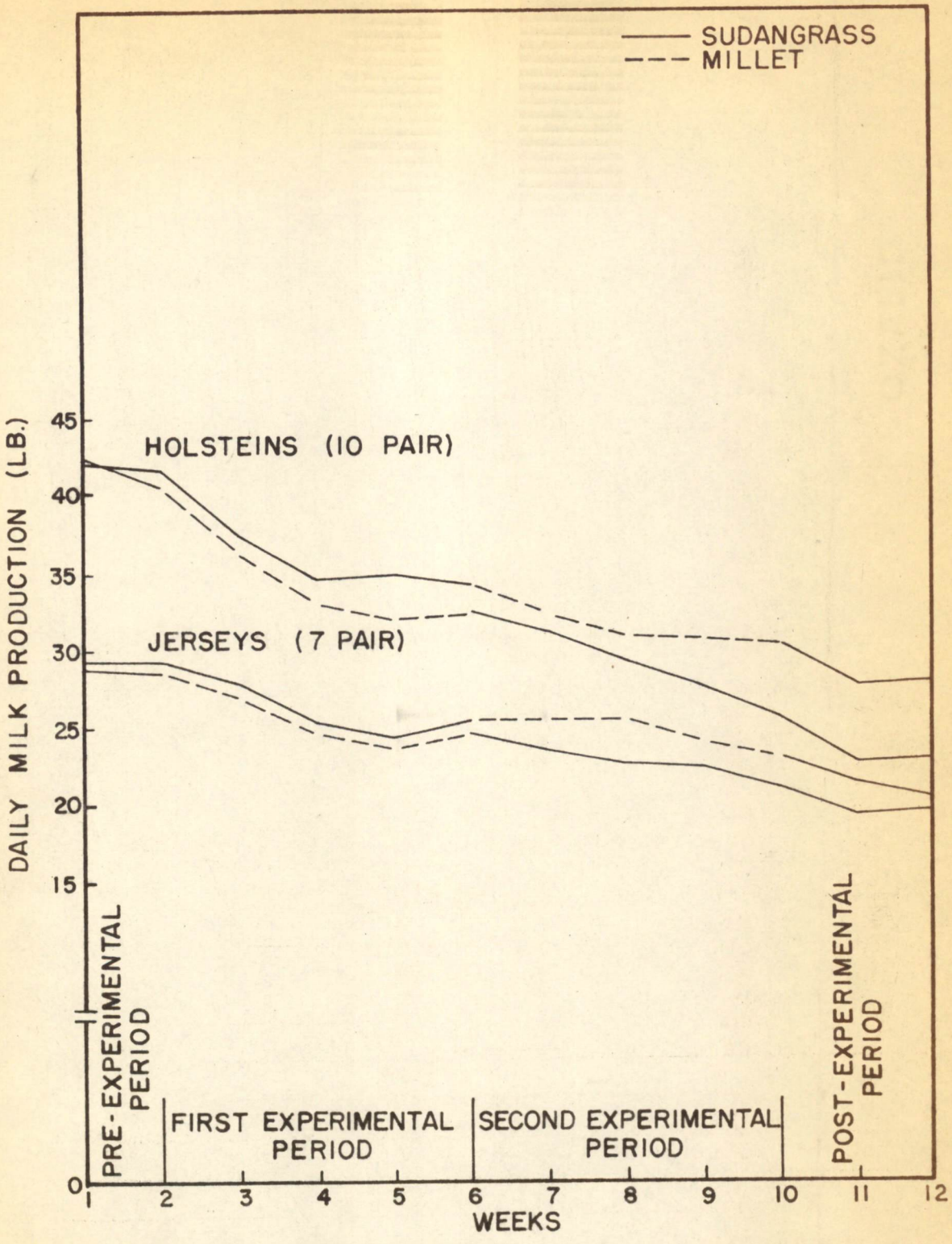

FIGURE 2. AVERAGE DAILY MILK PRODUCTION OF JERSEY AND HOLSTEIN COWS FED SUDANGRASS AND MILLET.

in milk production and 4% FCM.

Butterfat Production. The butterfat tests for all cows averaged 3.8% during the week preceeding the first experimental period. However, these tests were not made by the same person that made the butterfat determinations during the experimental periods.

The average butterfat test was 4.2% and 4.1% for the Sudangrass and millet fed groups, respectively, during the entire experiment. The average butterfat percentages for each week are shown in Table I. The milk produced by the cows receiving Sudangrass averaged 4.0% butterfat during the first 28 days of the experiment and the millet-fed group averaged 4.1% for the same period. During the second 28 days the average butterfat test for the Sudangrass-fed cows was 4.3% and the millet-fed group averaged 4.1%.

Statistically, there was not a significant difference at the 5% level of probability between the amount of butterfat produced by the cows on Sudangrass and millet. It can be seen in Appendix C that there was a significant difference between weeks, periods, and cows.

Total Solids Production. During the week preceeding the first experimental period the average percentage of total solids in the milk was 12.7. The average percentage of total solids during the entire experiment was 13.1 for the group fed Sudangrass and was the same for the group fed

millet. The average percentage of total solids for each group of cows is shown in Table I for each week during the experiment.

Statistical analysis of the total milk solids data showed no significant difference between the two forages nor weeks at the 5% level of probability. As shown in Appendix D there was a significant difference between periods and also between cows.

Body Weight. While on the experiment, the cows in both groups showed an average gain in body weight. The average smoothed body weight for each week is shown graphically in Figure 3. During the entire experiment, Sudangrass supported gains that averaged 33 lb. per cow and the millet supported an average gain of 25 lb. per cow. The group fed Sudangrass gained an average of 31 lb. during the first 28 days of the experiment and the group fed millet gained an average of 35 lb. During the second 28 days, the Sudangrass-fed group gained an average of 2 lb. per cow and the millet-fed group lost an average of 10 lb. per cow.

Analysis of observed weekly changes in body weights revealed that the difference between the two forages was not significant at the 5% level of probability. Neither was there any significant difference between cows at the same level of probability. However as expected, there was a significant difference between weeks and periods as shown in Appendix E.

TABLE I

WEEKLY AVERAGE MILK YIELDS, BUTTERFAT PER CENT, TOTAL SOLIDS, BODY WEIGHTS, AND FORAGE CONSUMPTION OF COWS FED SUDANGRASS AND MILLET

	WEEKS 1		2		3		4		ALL	
	I* SUDAN	II* MILLET	I SUDAN	II MILLET	I SUDAN	II MILLET	I SUDAN	II MILLET	I SUDAN	II MILLET
EXPERIMENTAL PERIOD I (JUNE 17-JULY 14)										
Daily 4% FCM (lb.)	32.4**	32.9	30.1	28.9	29.6	28.7	29.5	28.8	30.4	29.8
% Butterfat	4.1	4.2	4.0	4.0	3.9	4.2	3.9	4.1	4.0	4.1
% Total Solids	13.1	13.4	13.2	13.1	12.7	13.6	12.8	13.0	12.9	13.2
Body Weights (lb.)	1135	1161	1139	1170	1141	1180	1161	1195	1144	1177
Green Forage Consumption (lb.)	86.8	87.9	67.8	83.8	68.0	93.1	79.2	95.9	75.5	90.2

	WEEKS 5		6		7		8		ALL	
	II	I	II	I	II	I	II	I	II	I
EXPERIMENTAL PERIOD II (JULY 15-AUGUST 11)										
Daily 4% FCM (lb.)	27.7	29.2	27.1	29.1	26.0	27.1	25.8	28.2	26.7	28.4
% Butterfat	4.1	4.0	4.3	4.2	4.3	3.9	4.6	4.3	4.3	4.1
% Total Solids	13.0	12.8	13.3	13.0	13.3	12.8	13.6	13.2	13.3	13.0
Body Weights (lb.)	1199	1151	1203	1155	1199	1155	1197	1154	1200	1154
Green Forage Consumption (lb.)	70.6	101.9	66.4	97.6	68.6	82.0	70.5	79.9	69.0	90.4

* Groups I and II

** Each value is the average for 17 cows.

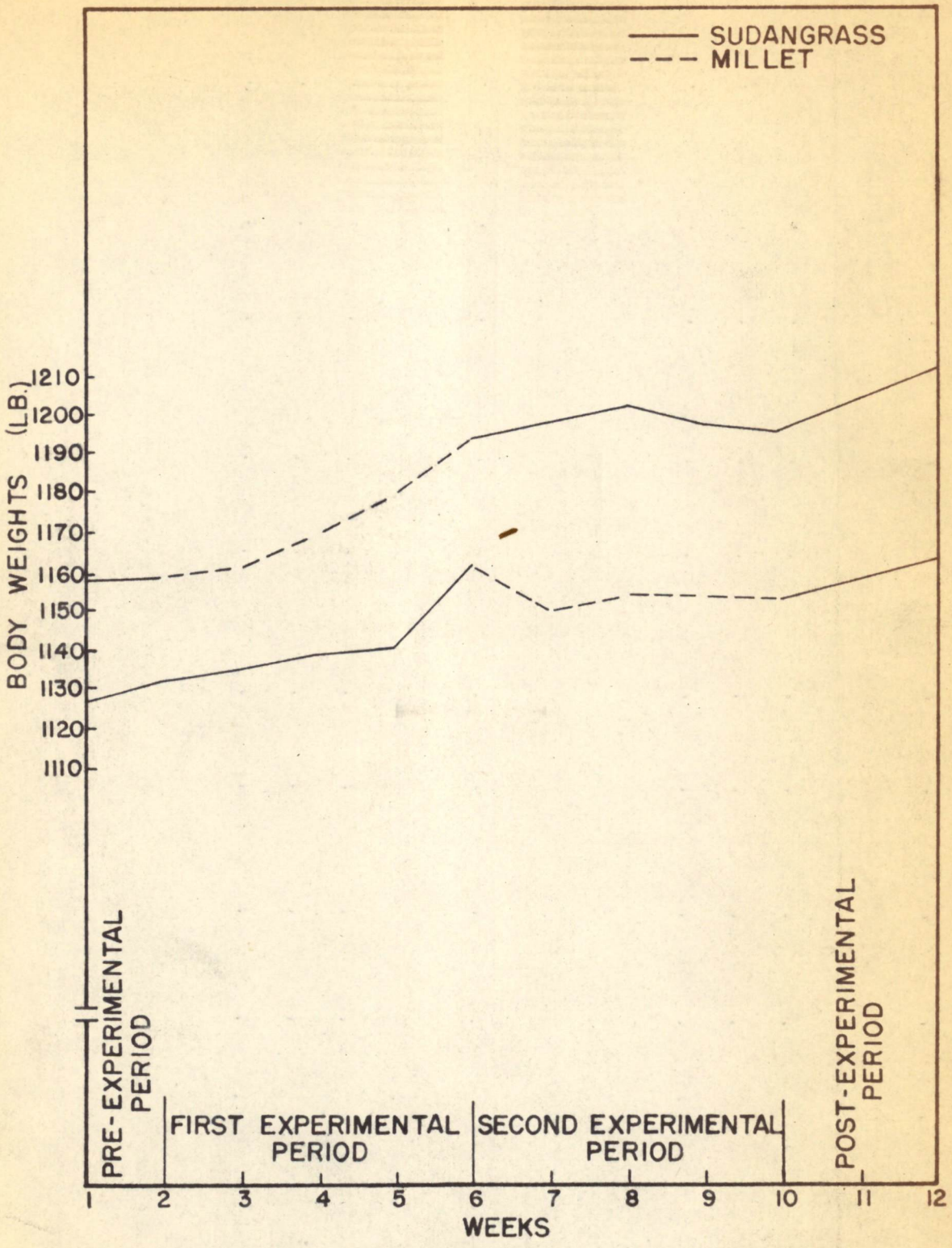

FIGURE 3. AVERAGE WEEKLY BODY WEIGHTS OF COWS FED SUDANGRASS AND MILLET.

Consumption of Forages, Hay, and Concentrates.

During the entire experiment the cows fed Sudangrass were offered an average of 98 lb. of green forage each day. Of this amount, an average of 24% was refused. The cows receiving millet were offered an average of 107 lb. of green forage daily of which 16% was refused. The average daily consumption of Sudangrass during the first 28 days of the experimental period was 76 lb. and the average daily consumption of millet was 90 lb. During the second 28 days of the experiment, after the groups were switched, the daily consumption of Sudangrass decreased to 69 lb. per cow while the consumption of millet remained high, averaging 90 lb. per cow. Table I shows the average daily consumption of green forage during the experiment.

The daily dry matter intake from Sudangrass averaged 14.8 lb. per cow, and the average daily dry matter intake from millet was 14.9 lb. during the entire experiment.

The daily consumption of hay was 3 lb. per cow for both groups during the two experimental periods. The same amount of grain was fed to both groups, which averaged 11 lb. per cow daily.

Chemical Analyses. The results of the chemical analyses of the forages are shown in Tables II and III. It can be seen that the percentage protein in the two forages was higher during the first period. However, the dry matter

TABLE II

ANALYSES OF COMPOSITE SUDANGRASS SAMPLES TAKEN THREE TIMES PER WEEK

WATER FREE BASIS

Week	% Protein	% Crude Fiber	% Ash	% Ether Extract	% Nitrogen Free Extract	* % Dry Matter in Fresh Cut Forage
	EXPERIMENTAL PERIOD I (JUNE 17-JULY 14)					
1	13.52	20.79	8.04	3.52	54.13	17.0
2	10.80	23.79	6.90	3.24	55.27	18.5
3	9.41	29.20	6.59	2.65	52.15	22.7
4	10.37	23.97	6.23	3.16	56.27	20.9
AVERAGE	11.02	24.44	6.94	3.14	54.46	19.8
	EXPERIMENTAL PERIOD II (JULY 14-AUGUST 11)					
5	9.83	26.58	6.23	2.60	54.76	18.5
6	9.42	29.60	4.44	2.27	54.27	21.6
7	11.17	25.15	7.51	2.49	53.68	20.0
8	10.17	27.35	7.55	2.29	52.64	25.0
AVERAGE	10.15	27.17	6.43	2.41	53.84	21.3
BOTH PERIODS	10.58	25.80	6.69	2.78	54.15	20.5

* Average determinations made from samples taken three times per week.

TABLE III

ANALYSES OF COMPOSITE MILLET SAMPLES TAKEN THREE TIMES PER WEEK

WATER FREE BASIS

Week	% Protein	% Crude Fiber	% Ash	% Ether Extract	% Nitrogen Free Extract	* % Dry Matter in Fresh Cut Forage
	EXPERIMENTAL PERIOD I (JUNE 17-JULY 14)					
1	15.88	19.40	12.93	3.41	48.48	12.7
2	12.13	25.05	10.38	3.05	49.39	14.6
3	13.34	29.30	9.99	2.31	45.06	15.2
4	13.01	22.39	8.18	3.57	52.85	17.6
AVERAGE	13.59	24.03	10.37	3.09	48.92	15.0
	EXPERIMENTAL PERIOD II (JULY 15-AUGUST 11)					
5	11.50	25.25	8.55	2.84	51.86	17.5
6	10.32	27.05	7.01	2.56	53.06	17.0
7	9.30	26.45	9.13	2.22	52.90	18.1
8	11.33	24.40	8.43	2.26	53.58	19.5
AVERAGE	10.61	25.79	8.28	2.47	52.85	18.0
BOTH PERIODS	12.10	24.91	9.32	2.78	50.89	16.5

* Average of determinations made from samples taken three times per week.

content increased as the experiment progressed. The average percentage protein was 10.6 for the Sudangrass and 12.1 for the millet during the entire experiment and the dry matter content was 20.5% in the Sudangrass and 16.5% in the millet for the same period of time.

The results of the chemical analyses of the hay and grain fed are shown in Appendix H. The composition of the hay remained about the same throughout the experiment. The TDN content of the hay was calculated by using the digestion coefficients shown in Morrison's (20) for the kind of hay fed. The average TDN content was 51% for the hay fed during the experiment. The grain mixture remained the same during the experiment, however, the chemical composition as shown in Appendix H, was not the same for both periods. Errors in sampling could have been responsible for this variation. The protein content was higher during the second 28 days of the experiment. The average calculated TDN content was 72% for the grain fed during the experiment.

Total Digestible Nutrients Furnished. The average daily requirement of TDN for the cows fed Sudangrass was 20.5 lb. and 20.6 lb. per cow for the group fed millet. This included the TDN needed for milk production, body maintenance, and the gain or loss in body weight. The hay and grain fed to each group furnished enough TDN for body maintenance. The amount of TDN derived from the forages is

shown in Tables IV and V. These tables show that Sudangrass furnished 54.6% of the required TDN and millet furnished 54.4%, during the entire experiment.

Yields of Each Forage. Daily weights of each chopped forage, plus the amount ensiled showed that Sudangrass yielded 8.4 tons of green forage per acre, and the yield of millet was 10.4 tons per acre. The yield of dry matter was 1.7 tons per acre from the Sudangrass and 1.7 tons per acre from the millet.

TABLE IV

TOTAL DIGESTIBLE NUTRIENT REQUIREMENTS FOR COWS FED SUDANGRASS AND THE PERCENTAGE FURNISHED BY GREEN FORAGE

Weeks	* Total Daily TDN Required Per Cow (lb.)	TDN Derived From Hay and Grain (lb.)	TDN Derived From Green Forage (lb.)	% TDN Derived From Hay and Grain	% TDN Derived From Green Forage
		EXPERIMENTAL PERIOD I (JUNE 17-JULY 14)			
1	20.9	9.4	11.5	45.0	55.0
2	21.6	10.1	11.5	46.8	53.2
3	19.6	9.5	10.1	48.5	51.5
4	29.4	9.2	20.2	31.3	68.7
AVERAGE	22.9	9.6	13.3	42.9	57.1
		EXPERIMENTAL PERIOD II (JULY 15-AUGUST 11)			
5	20.3	8.9	11.4	43.8	56.2
6	19.5	9.2	10.3	47.2	52.8
7	16.3	9.2	7.1	56.4	43.6
8	16.6	9.2	7.4	55.4	44.6
AVERAGE	18.2	9.1	9.1	50.7	49.3
BOTH PERIODS	20.5	9.3	11.2	45.4	54.6

* Each value represents the TDN required for milk production, body maintenance (20), and the changes in body weight (17).

TABLE V

TOTAL DIGESTIBLE NUTRIENT REQUIREMENTS FOR COWS FED MILLET AND THE PERCENTAGE FURNISHED BY GREEN FORAGE

Weeks	* Total Daily TDN Required Per Cow (lb.)	TDN Derived From Hay and Grain (lb.)	TDN Derived From Green Forage (lb.)	% TDN Derived From Hay and Grain	% TDN Derived From Green Forage
		EXPERIMENTAL PERIOD I (JUNE 17-JULY 14)			
1	21.0	9.5	11.5	45.2	54.8
2	23.7	10.8	12.9	45.6	54.4
3	23.5	9.5	14.0	40.4	59.6
4	25.6	9.2	16.4	35.9	64.1
AVERAGE	23.4	9.7	13.7	41.8	58.2
		EXPERIMENTAL PERIOD II (JULY 15-AUGUST 11)			
5	14.9	8.9	6.0	59.7	40.3
6	20.4	9.1	11.3	44.6	55.4
7	18.1	9.2	8.9	50.8	49.2
8	17.5	9.2	8.3	52.6	47.4
AVERAGE	17.7	9.1	8.6	51.9	48.1
BOTH PERIODS	20.6	9.4	11.2	45.6	54.4

* Each value represents the TDN required for milk production, body maintenance (20), and the changes in body weight (17).

DISCUSSION OF RESULTS

The results of this study agree with the results of Underwood *et al.* (29) in that the amount of milk produced by the cows fed Sudangrass and millet was not significantly different. However, the results obtained by Underwood *et al.* showed a difference in body weight gain in favor of Sudangrass. They used Tift Sudangrass instead of Piper but used the same variety of millet.

The cows were paired evenly in terms of milk production at the beginning of the pre-experimental period. But as shown in Figure 1, the group that was fed millet during the first 28 day experimental period did not maintain the same level of milk production as the group fed Sudangrass. Much of this difference in milk production was evident at the end of the pre-experimental period as shown in Figure 1. The difference between the two groups of cows remained the same until the third week of the first 28 day experimental period. The group that was fed millet initially, even when changed to Sudangrass, never maintained as high a level of milk production as the group that started the experiment on Sudangrass. This suggested that the difference in milk production was due to the grouping of cows rather than forages. During the post-experimental period, when both groups were fed the same kind of forage, milk production continued to be different. This

was additional evidence that the difference in milk production was caused by the difference in the cows.

Pairs 1 through 10, as shown in Appendix A, were the Holstein cows and pairs 11 through 17 were Jerseys. Both cows in pair 1 aborted. As shown in Appendix A this caused an increase in production of both cows, but a greater increase in one than the other. One of the cows in pair 3 maintained a higher level of milk production than the other. This could have been due to the fact that the higher producing cow remained open and the other cow was bred to calve about three months after the experiment was finished. One of the cows in pair 8 declined in milk production at a faster rate than her mate. There was no obvious explanation for this difference in milk production. The rate of milk production by cows in the other pairs was very similar.

The decline in milk production was greater than the 7% per month expected rate of decline (4). The group of cows that received Sudangrass declined 34.3% in milk production during the experimental periods which was about 20% more than expected. The group that received millet declined 28.5% during the experimental periods which was about 14% more than the expected rate. The group that received Sudangrass declined in milk production at the rate of 16.4% during the first experimental period, and the group that

received millet declined 18.3% during the same period. The group that received Sudangrass declined 17.9% during the second experimental period and the millet fed group declined only 10.2%. The group that was fed millet during the first 28 days and changed to Sudangrass declined at a greater rate than the other group as shown in Figure 1.

The low rate of consumption of green forage may have been a factor that caused this fast rate of decline in milk production. The forages were fed in a loafing shed that was very hot during the daytime. The cows remained out in the shade a large part of the day, thus, they spent less time eating. There was 26.9% more Sudangrass and 27.6% more millet consumed at night than during the daytime. This indicated that high temperatures may have been a factor responsible for low consumption. The cows were fed fresh cut forage in the afternoon, but the forage fed in the mornings had heated from setting overnight. This may have been another reason for the low rate of consumption.

The Sudangrass headed out faster than the millet, became stemmy, and had a leaf disease especially during the second growth in both fields. This also may have been a factor contributing to a lower consumption of Sudangrass than millet.

The percentage of TDN in Sudangrass and millet was calculated by use of Morrison's (20) digestion coefficients

for Sudangrass. Since there were no digestion coefficients listed for pearlmillet it was assumed that it had the same digestibility as Sudangrass. These calculations showed Sudangrass contained an average of 13.7% TDN and the millet contained an average of 10.2%. Since the same digestibility coefficients were used for both forages, these values reflect the difference in total nutrients. The percentage of TDN in Sudangrass and millet was also estimated by dividing the amount of green forage consumed daily per cow by the amount of TDN derived from the respective forages. The values shown in Table IV and V were used as the average percentage of TDN derived from each forage. This method of calculation showed Sudangrass contained 15.5% TDN and the millet contained 16.5%. This method showed less difference between the two forages and apparantly over estimated the TDN content of both forages.

The decline in milk production was accompanied by an increase in body weight as shown in Figures 1 and 3. Figure 3 shows a sharp increase in body weight during the sixth week. The groups were reversed the morning of the day the cows were weighed for that week. The increases in body weight were accredited to the kind of forage the cows had been receiving prior to that day. The group that increased the most in body weight consumed 21 lb. more grass per cow the morning prior to weighing than they had been consuming. This indicated

that the group fed Sudangrass during the previous week increased markedly in body weight. It gave reason to believe that the large increase in body weight during the sixth week for this group was due partially to the increase in the rate of consumption on weigh day.

These fluctuations in body weights were the cause for the fluctuation in TDN requirements as shown in Tables IV and V. The observed increase in body weights increased the TDN requirements for the 4th week as shown in Table IV. A loss in body weight decreased the TDN requirements of the millet fed cows during the 5th week, as shown in Table V. It is believed that the actual requirements did not vary as much as it appears in the tables and only appears as such because the TDN calculations are based partially on body weight changes.

This study gives only an indication of the value of Piper Sudangrass and Starr pearlmillet when fed to lactating cows. Use of this study as a basis for recommendations might be restricted, because it represents only one year's results.

SUMMARY

A total of 17 pairs of cows was used in this study. Each pair was fed hay and grain at the same rate. One group was fed Piper Sudangrass and the other group was fed Starr pearlmillet. Both forages were fed as soilage ad libitum. The experiment lasted 56 days during the summer of 1957 (June 17 to August 11). Mid-way of the experiment both groups were reversed so that the group that was receiving millet during the first experimental period was changed to Sudangrass and the other group was changed to millet.

Criteria used to determine the difference between the two grasses were daily milk production, weekly body weights, butterfat tests, and total solids tests. The yield of the two grasses was also measured.

Average daily 4% FCM produced during the entire experimental period was 28.5 lb. for cows receiving Sudangrass. The average daily 4% FCM production was 29.1 lb. for cows on millet. During the same period of time, the cows on Sudangrass gained an average of 33 lb. in body weight and cows on millet gained an average of 25 lb. per cow.

Statistical analyses of milk production, 4% FCM, butterfat, body weight changes, and total solids showed no

significant difference between the two forages when fed to lactating dairy cows.

The cows receiving Sudangrass derived 54.6% of their calculated TDN intake from the green forage and the group that received millet derived 54.4% of their calculated TDN intake from green forage. The average daily consumption of Sudangrass during the experiment was 72 lb. while the average daily consumption of millet was 90 lb. The dry matter consumption was 14.8 lb. daily per cow from the Sudangrass and 14.9 lb. daily per cow from the millet.

The yield of Sudangrass was 8.4 tons per acre and the yield of millet was 10.4 tons per acre. The yield of dry matter was 1.7 tons per acre from the Sudangrass and 1.7 tons per acre from the millet.

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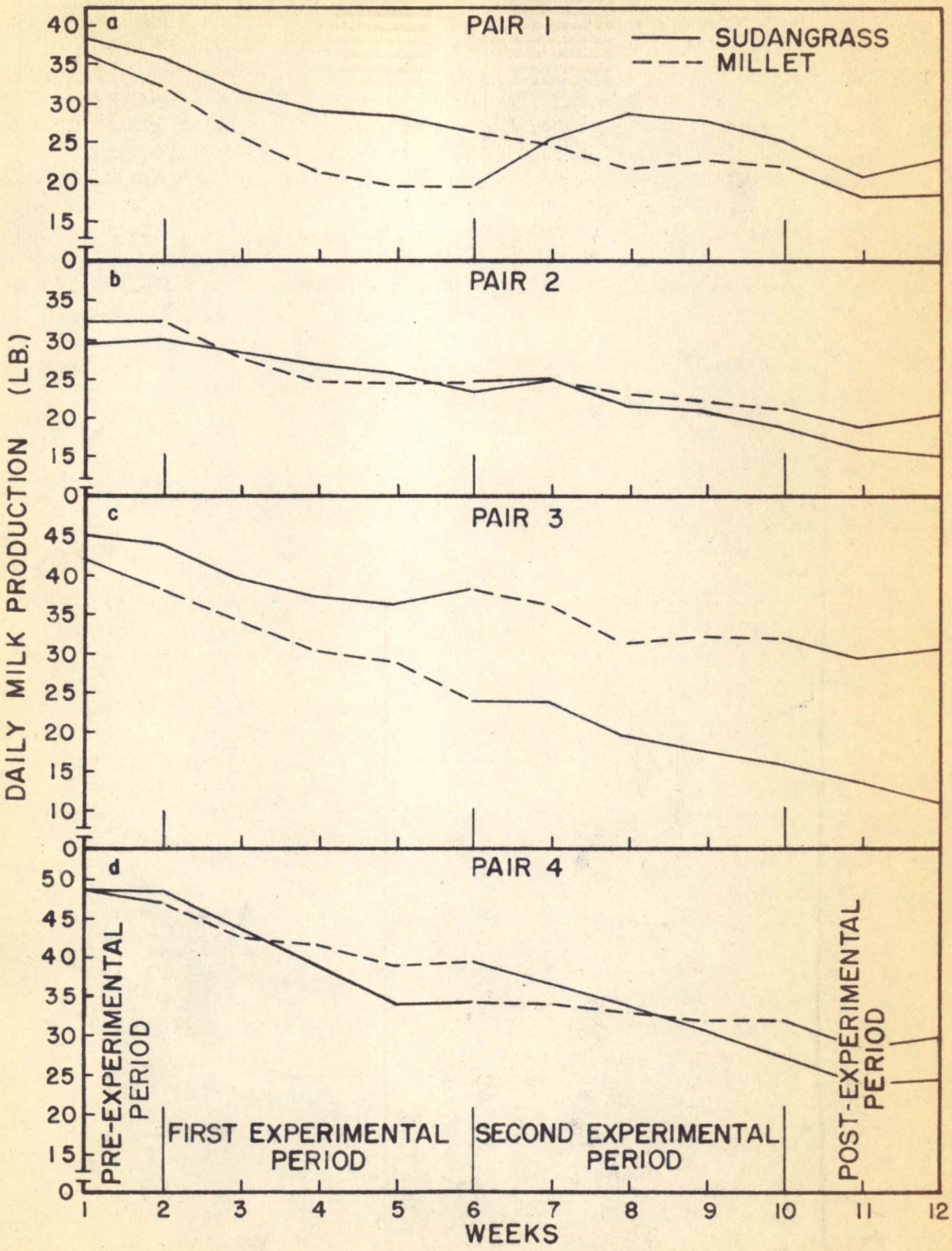
APPENDICES

APPENDIX A
AVERAGE DAILY MILK PRODUCTION OF COWS FED SUDANGRASS AND MILLET



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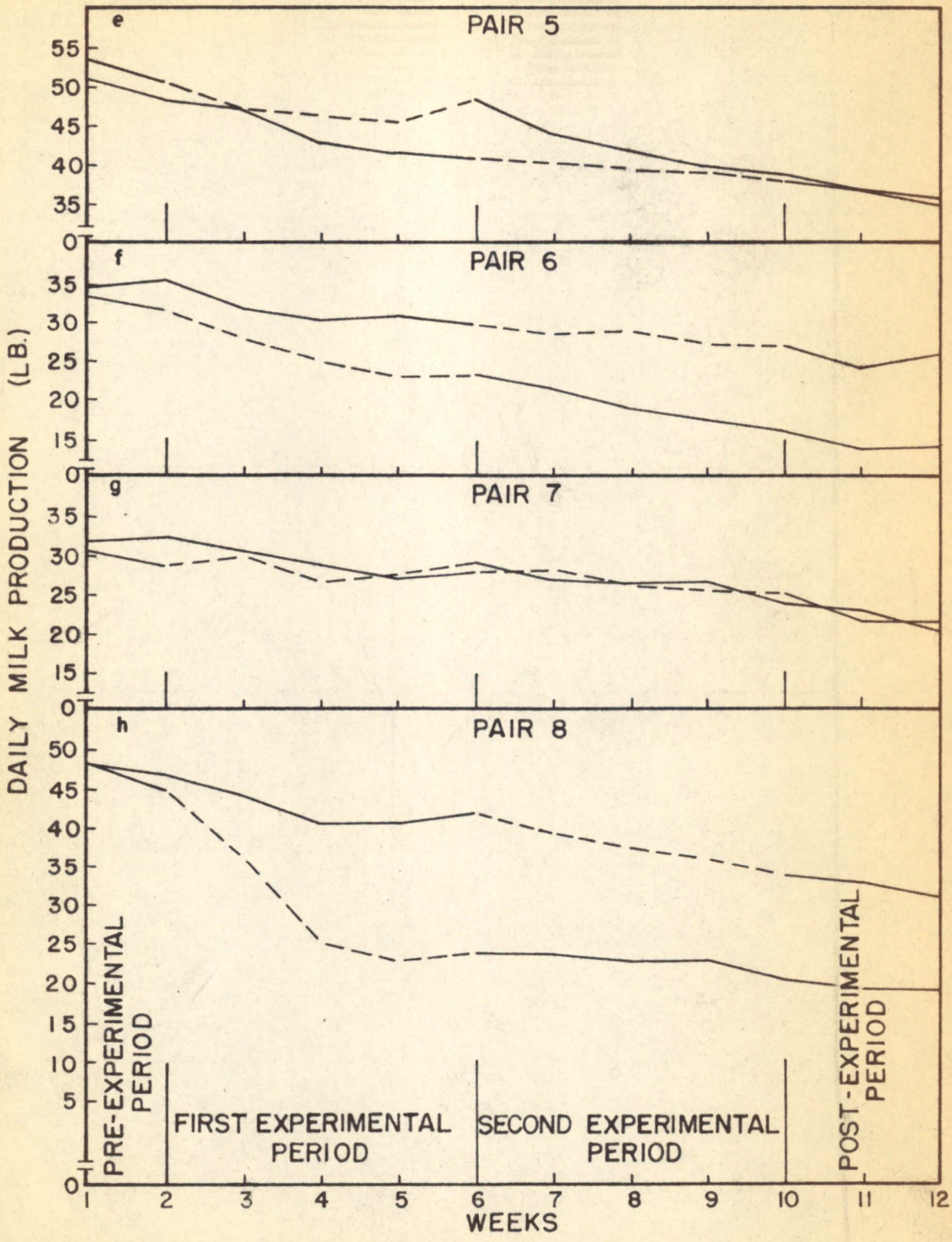

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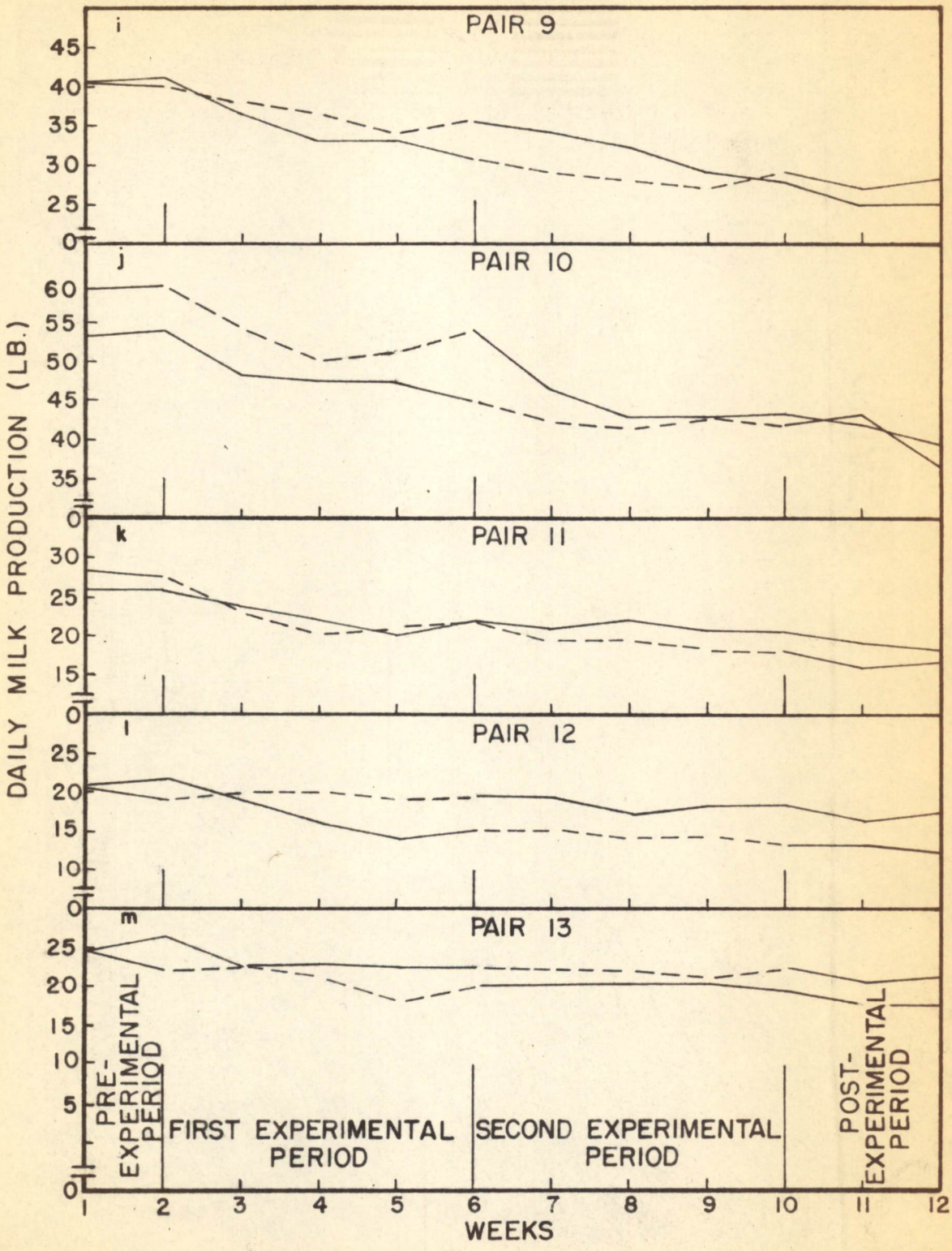

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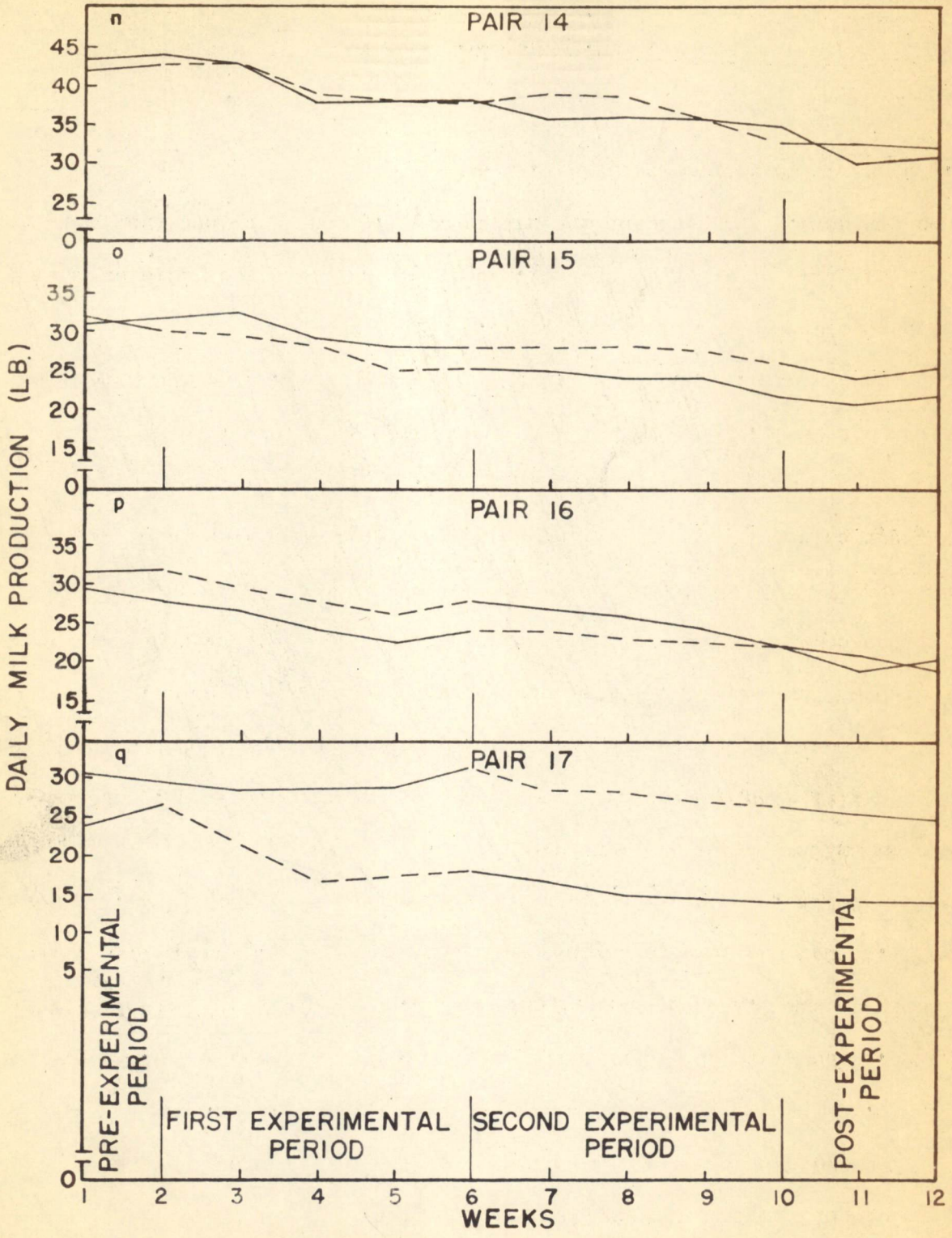

APPENDIX B

ANALYSIS OF VARIANCE OF WEEKLY 4% FCM PRODUCED BY COWS FED SUDANGRASS AND MILLET

Source of Variation	D/F	Sum of Squares	Mean Square	F
Total	271	723,457		
Between Forages	1	941	941	3.41
Between Weeks	7	44,240	6,320	22.9**
Between Periods	1	23,495	23,495	85.1**
Between Weeks Within Periods	6	20,755	3,459	12.5**
Between Cows Within Periods	32	614,557	19,205	69.6**
Remainder	231	63,719	276	

** Significant at 1% level of probability.

APPENDIX C

ANALYSIS OF VARIANCE OF WEEKLY POUNDS OF BUTTERFAT PRODUCED BY COWS FED SUDANGRASS AND MILLET

Source of Variation	D/F	Sum of Squares	Mean Square	F
Total	271	1,221		
Between Forages	1	2	2	2.58
Between Weeks	7	83	12	15.50**
Between Periods	1	57	57	73.64**
Between Weeks Within Periods	6	26	4	5.17*
Between Cows Within Periods	32	957	30	38.75**
Remainder	231	179	.775	

* Significant at 5% level of probability.
** Significant at 1% level of probability.

APPENDIX D

ANALYSIS OF VARIANCE OF WEEKLY TOTAL SOLIDS PRODUCED BY COWS FED SUDANGRASS AND MILLET

Source of Variation	D/F	Sum of Squares	Mean Squares	F
Total	271	177,675		
Between Forages	1	19	19	.026
Between Weeks	7	934	133	.185
Between Periods	1	525	525	.732**
Between Weeks Within Periods	6	409	68	.095
Between Cows Within Periods	32	11,034	345	.481*
Remainder	231	165,688	717	

* Significant at 5% level of probability.
** Significant at 1% level of probability.

APPENDIX E

ANALYSIS OF VARIANCE OF OBSERVED WEEKLY BODY WEIGHT CHANGES OF COWS FED SUDANGRASS AND MILLET

Source of Variation	D/F	Sum of Squares	Mean Squares	F
Total	271	165,565		
Between Forages	1	957	957	1.97
Between Weeks	7	36,189	5,169	10.64**
Between Periods	1	5,717	5,717	11.76**
Between Weeks Within Periods	6	30,472	5,079	10.45**
Between Cows Within Periods	32	16,215	507	1.04
Remainder	231	112,204	486	

** Significant at 1% level of probability.

APPENDIX F

BASIS USED IN PAIRING THE HOLSTEIN COWS

Pair	Cow	Age At Last Calving Yr. Mo.	Days in Lactation As of June 1, 1957	Days in Gestation As of June 1, 1957	* Average Daily Milk Production (lb.)	Body Weight As of June 12 1957 (lb.)
1	154	3-11	175	138	38.6	1250
	134	4-03	186	132	38.3	1381
2	77	7-00	180	0	33.5	1400
	131	4-08	185	139	34.2	1150
3	156	4-08	150	0	44.6	1255
	135	4-02	212	134	43.7	1520
4	126	4-10	183	65	49.5	1268
	117	5-01	188	120	48.5	1420
5	89	6-01	217	0	51.6	1507
	123	5-00	158	63	53.3	1490
6	172	3-00	210	131	35.2	1210
	158	3-07	211	59	36.2	1304
7	183	2-08	216	131	30.1	1362
	180	2-08	238	135	30.6	1214
8	148	4-03	150	63	46.5	1245
	50	7-03	118	67	51.1	1590
9	71	7-03	147	58	44.0	1345
	118	4-09	311	67	40.5	1605
10	22	8-07	57	0	54.3	1540
	149	2-09	89	0	61.8	1170

* Average daily milk production for the preceeding month (May, 1957).

APPENDIX G

BASIS USED IN PAIRING THE JERSEY COWS

Pair	Cow	Age At Last Calving Yr. Mo.	Days in Lactation As of June 1, 1957	Days in Gestation As of June 1, 1957	* Average Daily Milk Production (lb.)	Body Weight As of June 12, 1957 (lb.)
11	136	5-04	163	66	27.0	862
	139	5-02	215	0	28.3	935
12	179	3-04	172	90	21.3	850
	176	3-03	209	150	20.2	910
13	204	2-08	132	66	25.7	697
	205	2-05	170	101	24.4	640
14	161	4-10	17	0	38.8	855
	128	6-00	17	0	33.9	880
15	123	5-10	126	69	34.4	980
	162	4-04	144	63	32.4	830
16	221	2-02	55	12	29.8	668
	174	4-10	76	0	32.2	780
17	163	4-06	77	0	31.2	760
	112	6-02	172	75	29.1	785

* Average daily milk production for the preceeding month (May, 1957).

APPENDIX H

COMPOSITION OF THE HAY AND GRAIN SAMPLES TAKEN ONCE EACH PERIOD

WATER FREE BASIS

	% Protein	% Crude Fiber	% Ash	% Ether Extract	% Nitrogen Free Extract	% Dry Matter
EXPERIMENTAL PERIOD I (JUNE 17-JULY 14)						
Hay	11.85	29.20	5.79	1.09	52.07	90.07
Grain	14.74	8.64	3.27	3.52	69.82	90.30
EXPERIMENTAL PERIOD II (JULY 15-AUGUST 11)						
Hay	11.15	28.70	6.08	1.89	52.18	89.96
Grain	16.81	9.31	3.07	3.78	67.03	89.40