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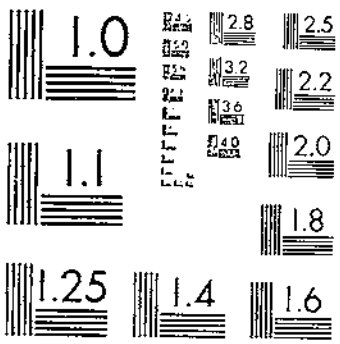

MICROCOPY RESOLUTION TEST CHART
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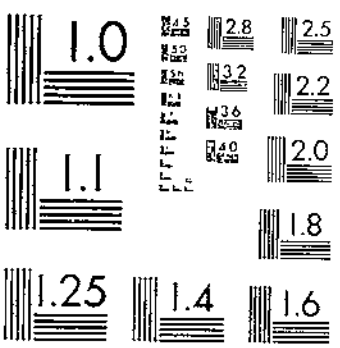

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1964-A

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SEASONAL VARIATIONS IN CARRYING CAPACITY OF PASTURES FOR DAIRY COWS IN MILK

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INTRODUCTION

Conditions in most localities are more favorable for pasture growth in the spring than in the late summer months, hence, there is likely to be more grass in the spring than the dairy herd can consume and not enough later in the season to meet the needs of the herd. If the size of the pasture is such that it will supply the right amount of grass for a given number of cows during the season of most rapid growth, then that same pasture will not provide enough for the cows during the season of slower growth. If the size of the pasture is adjusted to meet the needs of a certain number of cows during the season of slowest growth, the grass will become too mature during the season of most rapid growth, for it will grow faster than the cows can consume it.

Grasses are very different in their nutritive composition at different stages of maturity. Immature grass is relatively high in protein and low in crude fiber. As the grass matures the percentage of protein decreases and that of crude fiber increases. The immature grass has a composition that makes it more efficient for milk production than mature grass. Consequently a pasture that is undergrazed during the season of most rapid growth will soon have a stand of grass that is too mature for efficient milk production.

Cows usually increase somewhat in their milk flow when turned on good pasture in the spring, but it is very common in many sections for their milk flow to decline rapidly after they have been on pasture a few weeks. This may be due to the grass having passed

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the most favorable stage of maturity for milk production or it may be due to an insufficient amount of grass to meet the needs of the cow for maintenance and production. A good producing cow will need to consume from 100 to 150 pounds of grass a day in order to obtain the nutrients she requires. The exact amount will depend on her size, on the amount of milk she produces, and on the quality of the grass. A pasture must be good to supply this amount of grass, but it is not easy to gage a large pasture and determine whether it has sufficient grass, readily available and of the right quality, to meet the nutritive needs of a herd of dairy cows.

If a pasture is sufficiently good one week, can it be depended upon to be good enough 2 weeks later? Or a month later? How rapidly does a pasture change from good to bad? What is the difference in carrying capacity of a pasture from one season to another? To throw some light on these questions the writers have made use of the available data at the various stations of the Bureau of Dairy Industry and have supplemented these with data from eight other stations.

SOURCES OF DATA AND THE METHOD OF PRESENTATION

The information presented in this publication is based on data obtained from pasture studies at the United States Dairy Experiment Station at Beltsville, Md., at the various field stations of the Bureau of Dairy Industry, at cooperating State experiment stations, and from published results of other pasture studies.

Practically all the data used in this study represent measured areas of pasture grasses that were clipped at stated intervals. From the weights of the grass (dry-matter basis)[1] obtained at each clipping the writers have calculated the average daily yield of dry matter per acre, by dividing the total dry weight of the clipping by the number of days' growth it represented, for such periods of the grazing season as was possible from the data available. The yield of dry matter per day, which gives an indication of the rate of growth of the grass, is shown in tabular form for each pasture studied.

To make the data more readily understood by those accustomed to thinking of pasture in terms of the number of acres required to support a cow, the writers have also calculated, for each period for which the yield of dry matter is available, the acreage that would be required to provide sufficient nutrients for the maintenance of a 1,000-pound cow and for the daily production of 25 pounds of milk having a butterfat content of 4 percent. A cow of this size and with this production will require 16.125 pounds of total digestible nutrients per day, on the basis of the Morrison standard. The relation between the digestible nutrients and dry matter was arrived at by applying digestion coefficients to average pasture grass. The digestion coefficient (69 percent of dry matter) used in these calculations represents an average between that reported by Armsby (*1*)[2] and that secured at the Beltsville station, both of which were

[1] Samples of grass from the United States field stations at Beltsville, Md., Jeanerette, La., and Huntley, Mont., were analyzed for their dry-matter content by C. B. Parker, junior chemist, Bureau of Dairy Industry.

[2] Italic numbers in parentheses refer to Literature Cited, p. 20.

based on digestion trials with green grass. The amount of dry matter required to provide 16.125 pounds of digestible nutrients on this basis is 23.4 pounds.

Although the average daily production of dry matter as shown in the various tables gives an indication of the rate of growth of the grass, it seemed desirable to present the data in graphs also in order that the reader might better visualize the seasonal growth of the grass.

In preparing the graphs from the tables the average number of pounds of dry matter produced per acre per day was plotted at the mean of the period of growth. For example, see figure 1, *A*. The first clipping in 1929 was made May 10, and represented 40 days' growth, assuming that growth began April 1. The average yield of dry matter per acre per day as shown in table 2 was 11.7 pounds for the 40-day period. This number was plotted (fig. 1, *A*) at the mean of the period, which was April 20. The second clipping was on May 21, and represented the 11 days' growth between May 10 and May 21. The average daily yield of dry matter per acre for this 11-day period was 19.4 pounds. This number was plotted (fig. 1, *A*) at the mean of the second period, which was May 15, and so on for all subsequent periods of growth. Although the graphs fail to depict accurately the maximum growth or the exact time that the growth took place, there seems to be no better way to show the seasonal growth of grasses on the basis of the data available.

YIELD OF DRY MATTER PER ACRE PER DAY AND THE ACREAGE REQUIRED TO SUPPORT ONE MILKING COW

RESULTS AT BELTSVILLE, MD.

MIXTURE OF KENTUCKY BLUEGRASS, ORCHARD GRASS, AND WHITE CLOVER

In the spring of 1929 a ½-acre plot (plot 1) in a 5-year-old permanent pasture was fenced off for the purpose of determining the seasonal growth of the grass. This pasture would be termed good for the locality represented. The predominating plants on plot 1, in the order of their prevalence, during the four seasons studied, were as follows: 1929, orchard grass, Kentucky bluegrass, and white clover; 1931, Kentucky bluegrass, orchard grass, and white clover; 1932, white clover, Kentucky bluegrass, and orchard grass; 1933, Kentucky bluegrass, white clover, and orchard grass.

The orchard grass was gradually replaced by Kentucky bluegrass and white clover. As a rule the grasses predominated in the spring and the white clover in the summer. In 1932, however, the white clover predominated in both spring and summer. Before this plot was fenced off, the pasture had been generously manured but no lime or fertilizer had been applied since the pasture was first seeded in 1924 until the spring of 1933 when certain portions were treated with lime and superphosphate.

The plan was to clip this ½-acre plot back to a height of 2 inches every 10 days with an ordinary horse-drawn mower equipped with a collecting pan on the back of the cutter bar. It was found in many cases, however, that the 10 days' growth was not high enough to be clipped and the clippings recovered. In such cases clipping was

deferred. As the season of 1930 was excessively dry and not representative of any usual season, it was thought that the data on the clippings would serve no practical purpose, and for this reason they are omitted from this report.

The precipitation at Beltsville, Md., for the four seasons is shown in table 1.

TABLE 1.—*Monthly precipitation (in inches) at Beltsville, Md., for the four pasture seasons studied*

Season	March	April	May	June	July	August	September	October
1929	2.64	6.48	2.92	7.09	1.06	1.65	2.33	4.43
1931	3.84	2.20	3.87	4.75	4.58	7.90	1.22	1.16
1932	5.59	2.45	4.94	3.72	2.70	1.53	3.67	6.38
1933	3.22	5.43	4.37	3.88	5.51	10.51	1.98	1.97

Precipitation in the summers of 1929 and 1932 was below normal. The first part of the 1931 season was cold, which together with the drought of the preceding year hindered the growth of the grass early in the season. The heavy rains in August of 1931 and 1933 caused a big increase in the yields. The influence of these rains on the yield of grass on plot 1 is readily seen in table 2 and in figure 1, *A*.

TABLE 2.—*The yield of dry matter per acre per day and the estimated carrying capacity of pasture plots at Beltsville, Md., 1929 and 1931–33*

Plot no., year, and period of growth [1]	Dry matter per acre per day	Area required to support one milking cow
Plot 1 (1929):	*Pounds*	*Acres*
Apr. 1 to May 10	11.7	2.0
May 10 to May 21	19.4	1.2
May 21 to May 31	11.6	2.0
May 31 to June 10	9.3	2.5
June 10 to June 20	5.5	4.3
June 20 to July 1	9.5	2.5
July 1 to July 11	10.8	2.2
July 11 to July 23	3.7	6.3
July 23 to Aug. 12	1.2	19.5
Aug. 12 to Sept. 12	.9	26.0
Sept. 12 to Oct. 24	1.1	21.3
Plot 1 (1933):		
Apr. 1 to Apr. 25	3.9	6.0
Apr. 25 to May 17	41.7	.6
May 17 to June 6	12.6	1.9
June 6 to July 6	14.3	1.6
July 6 to July 24	8.9	2.6
July 24 to Aug. 30	8.3	2.8
Aug. 30 to Sept. 20	18.0	1.3
Sept. 20 to Oct. 19	3.4	6.9
Plot 3 (1933):		
Apr. 1 to Apr. 25	5.6	4.2
Apr. 25 to May 17	38.1	.6
May 17 to June 6	16.5	1.4
June 6 to July 6	19.6	1.2
July 6 to July 24	14.2	1.6
July 24 to Aug. 30	19.8	1.2
Aug. 30 to Sept. 20	28.9	.8
Sept. 20 to Oct. 19	6.0	3.9
Plot 1 (1931):	*Pounds*	*Acres*
Apr. 1 to May 22	11.6	2.0
May 22 to June 3	15.9	1.5
June 3 to June 26	13.0	1.8
June 26 to July 14	7.6	3.1
July 14 to Aug. 13	12.1	1.9
Aug. 13 to Sept. 1	17.6	1.3
Sept. 1 to Sept. 24	8.1	2.9
Plot 2 (1932):		
Apr. 1 to May 6	16.0	1.5
May 6 to May 17	43.2	.5
May 17 to June 1	18.3	1.3
June 1 to June 30	13.2	1.8
June 30 to July 13	8.7	2.7
July 13 to Aug. 24	1.3	18.0
Aug. 24 to Oct. 3	3.9	6.0
Plot 4 (1931):		
Apr. 1 to May 6	14.9	1.6
May 6 to May 20	31.8	.7
May 20 to June 3	14.1	1.7
June 3 to June 26	11.3	2.1
June 26 to July 14	6.5	3.6
July 14 to Aug. 13	14.7	1.6
Aug. 13 to Sept. 1	13.9	1.7
Sept. 1 to Sept. 24	11.2	2.1
Plot 1 (1932):	*Pounds*	*Acres*
Apr. 1 to May 6	7.4	3.2
May 6 to May 17	37.3	.6
May 17 to June 1	16.0	1.5
June 1 to June 30	11.5	2.0
June 30 to July 13	7.3	3.2
July 13 to Aug. 24	1.4	16.7
Aug. 24 to Oct. 3	1.8	13.0
Plot 2 (1933):		
Apr. 1 to Apr. 25	14.4	1.6
Apr. 25 to May 17	41.4	.6
May 17 to June 6	13.2	1.8
June 6 to July 6	17.5	1.3
July 6 to July 24	11.6	2.0
July 24 to Aug. 30	14.2	1.6
Aug. 30 to Sept. 20	18.6	1.3
Sept. 20 to Oct. 18	8.2	2.9
Plot 5 (1931):		
Apr. 1 to May 6	15.2	1.5
May 6 to May 20	22.3	1.0
May 20 to June 3	11.6	2.0
June 3 to June 26	10.9	2.1
June 26 to July 14	6.9	3.4
July 14 to Aug. 13	11.0	2.1
Aug. 13 to Sept. 1	8.8	2.7
Sept. 1 to Sept. 24 [2]	14.1	1.7

[1] Growth assumed to start Apr. 1. The last day of each period of growth is the clipping date.
[2] Mostly crabgrass.

Table 2 shows that in each of the four seasons the greatest growth of grass on plot 1 occurred in May. The greatest growth after May was in June, July, August, or September, depending on the rainfall. The variation in the latter part of the season is tremendous. The growth in August or September may be 20 times as much in some years as it is in others.

The total yield of dry matter for a year also varied greatly but not so much as the seasonal yield. In 1929 the total yield of dry matter was 1,302 pounds; in 1931, 2,112 pounds; in 1932, 1,477 pounds; and in 1933, 2,639 pounds. From these yields for the four seasons it is estimated that 1 acre would have provided the nutrients required by one milking cow for 56, 90, 63, and 113 days, respectively. This pasture yielded twice as much in 1933 as in 1929. The seasonal growth of the grass is shown in figure 1, *A*.

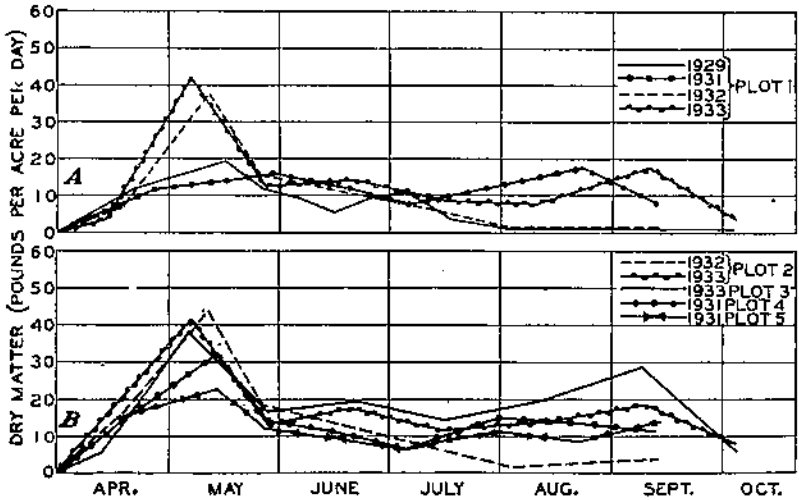

FIGURE 1.—Seasonal growth of grasses at Beltsville, Md., 1929 and 1931–33: *A*, Kentucky bluegrass, orchard grass, and white clover (plot 1); *B*, an old pasture of Kentucky bluegrass and white clover (plots 2 and 3), a new pasture of Kentucky bluegrass, orchard grass, and redtop (plot 4), and Reed canary grass (plot 5).

MISCELLANEOUS PASTURE PLOTS

Later two more plots (plots 2 and 3) in the same pasture as plot 1 were fenced off and clipped in the same way. The only material difference between these two plots and plot 1 was that plot 2 was located on a soil of a little greater fertility than plot 1, and plot 3 had received an application of manure at the rate of 16 tons to the acre. Plot 2 was clipped in 1932 and in 1933; plot 3 only in 1933.

In addition, two other plots were clipped for study. One of these, plot 4, was a pasture mixture 2 years old in which the plants in order of predominance were Kentucky bluegrass, orchard grass, and redtop. The other, plot 5, was a somewhat imperfect stand of Reed canary grass, 2 years old. Plots 4 and 5 were clipped only during the season of 1931. The yield of dry matter and the estimated carrying capacity of plots 2, 3, 4, and 5 are shown in table 2.

Plot 2 yielded 2,035 pounds of dry matter per acre in 1932 and 3,416 pounds in 1933; plot 3 yielded 3,665 pounds in 1933; plot 4

yielded 2,518 pounds in 1931; and plot 5 yielded 2,219 pounds in 1931. These yields were sufficient to provide the nutrients for 87, 146, 157, 108, and 95 cow-days respectively. The seasonal growth of grass on plots 2, 3, 4, and 5 is shown in figure 1, *B*.

PLUCKED PLOTS IN FERTILIZED AND UNFERTILIZED PASTURES

The influence of a complete fertilizer on the yield of pasture grass is being determined at the Beltsville station by the Bureau of Dairy Industry in cooperation with the Bureau of Plant Industry. In each of two fields, one fertilized and the other unfertilized, that are being grazed by dairy cattle, one or more plots 10 feet square have been fenced off. At intervals throughout the grazing season these plots (plots 6, 7, 8, and 9) are plucked by hand to a height approximately the same as that to which the surrounding grass has been grazed. As the grass is ordinarily grazed closer in the latter part of the season than during the first part, the pluckings fail to show the actual seasonal growth as accurately as the clippings do. But they do represent more accurately the amount of grass ordinarily grazed by cattle.

Kentucky bluegrass was the predominating grass in both the fertilized and unfertilized pastures. The legumes in the fertilized pastures were present only in small amounts, but in the unfertilized pasture common lespedeza gradually increased in prevalance until in 1933 the growth after July 1 consisted mostly of the lespedeza. Plots 7 and 8 were located on a different pasture, which was similar to that on which plot 6 was located. Plots 7 and 8 differ from each other only with respect to the form in which the nitrogen was applied. Plot 9 was in the unfertilized pasture.

The yields of dry matter and the estimated carrying capacity of the fertilized pastures (plots 6, 7, and 8) and of the unfertilized pasture (plot 9) are shown in table 3.

TABLE 3.—*The yield of dry matter per acre per day and the estimated carrying capacity of plucked plots in fertilized and unfertilized pastures at Beltsville, Md., 1931–33*

FERTILIZED KENTUCKY BLUEGRASS

Plot no., year, and period of growth [1]	Dry matter per acre per day	Area required to support one milking cow	Plot no., year, and period of growth [1]	Dry matter per acre per day	Area required to support one milking cow	Plot no., year, and period of growth [1]	Dry matter per acre per day	Area required to support one milking cow	Plot no., year, and period of growth [1]	Dry matter per acre per day	Area required to support one milking cow
Plot 6 (1931):	*Pounds*	*Acres*	Plot 6 (1932):	*Pounds*	*Acres*	Plot 7 (1933):	*Pounds*	*Acres*	Plot 8 (1933):	*Pounds*	*Acres*
Apr. 1 to May 19	30.6	0.8	Apr. 1 to May 2	10.3	2.3	Apr. 1 to Apr. 24	14.5	1.6	Apr. 1 to Apr. 24	9.9	2.4
May 19 to June 4	78.5	.3	May 2 to May 10	71.6	.3	Apr. 24 to May 3	91.5	.3	Apr. 24 to May 3	75.4	.3
June 4 to June 30	34.0	.7	May 10 to May 17	72.6	.3	May 3 to May 15	55.8	.4	May 3 to May 15	71.9	.3
June 30 to July 17	16.9	1.4	May 17 to May 23	29.6	.8						
July 17 to Aug. 3	18.5	1.3	May 23 to June 1	53.3	.4	May 15 to June 3	42.7	.5	May 15 to June 3	40.4	.6
Aug. 3 to Sept. 1	26.9	.9	June 1 to June 15	13.4	1.7						
Sept. 1 to Sept. 9	61.9	.4	June 15 to June 30	40.6	.6	June 3 to July 5	15.2	1.5	June 3 to July 5	12.1	1.9
Sept. 9 to Oct. 3	10.9	2.1	June 30 to July 13	10.3	2.3	July 5 to Aug. 2	26.0	.9	July 5 to Aug. 2	24.6	1.0
Oct. 3 to Oct. 13	4.8	4.9	July 13 to Aug. 1	15.1	1.5	Aug. 2 to Aug. 31	16.4	1.4	Aug. 2 to Aug. 31	20.0	1.2
			Aug. 1 to Sept. 14	3.0	7.8	Aug. 31 to Oct. 2	20.4	1.1	Aug. 31 to Oct. 2	24.5	1.0
			Sept. 14 to Oct. 1	10.3	2.3	Oct. 2 to Oct. 25	10.9	2.1	Oct. 2 to Oct. 25	23.9	1.0

UNFERTILIZED KENTUCKY BLUEGRASS AND LESPEDEZA

Plot no., year, and period of growth [1]	Dry matter per acre per day	Area required to support one milking cow	Plot no., year, and period of growth [1]	Dry matter per acre per day	Area required to support one milking cow	Plot no., year, and period of growth [1]	Dry matter per acre per day	Area required to support one milking cow
Plot 9 (1931):	*Pounds*	*Acres*	Plot 9 (1932):	*Pounds*	*Acres*	Plot 9 (1933):	*Pounds*	*Acres*
Apr. 1 to May 19	14.5	1.6	Apr. 1 to May 2	6.5	3.6	Apr. 1 to May 3	3.5	6.7
May 19 to June 4	70.4	.3	May 2 to May 10	49.1	.5			
June 4 to June 30	48.6	.5	May 10 to May 17	41.3	.6	May 3 to May 15	37.3	.6
June 30 to July 17	7.8	3.0	May 17 to May 23	32.2	.7			
July 17 to Aug. 3	6.6	3.5	May 23 to June 1	38.0	.6	May 15 to June 3	36.5	.6
Aug. 3 to Sept. 1	20.0	1.2	June 1 to June 15	12.6	1.9	June 3 to July 5	22.6	1.0
Sept. 1 to Sept. 9	40.8	.6	June 15 to June 30	26.2	.9	July 5 to Aug. 2	31.3	.7
Sept. 9 to Oct. 3	15.8	1.5	June 30 to Aug. 1	7.1	3.3	Aug. 2 to Aug. 31	21.4	1.1
Oct. 3 to Oct. 13	9.1	2.6	Aug. 1 to Sept. 14	6.4	3.7			
			Sept. 14 to Oct. 1	4.3	5.4	Aug. 31 to Oct. 2	18.7	1.3
						Oct. 2 to Oct. 25	2.4	9.8

[1] Growth assumed to start Apr. 1. The last day of each period of growth is the date the grass was plucked.

The total yields of dry matter per acre for the season on the 3 plots of the fertilized pastures were as follows: Plot 6, 5,828 pounds in 1931, and 3,595 pounds in 1932; plot 7, 5,244 in 1933; and plot 8, 5,534 pounds in 1933. These yields were sufficient for 249, 154, 224, and 236 cow-days of grazing, respectively.

Total yields of dry matter on the unfertilized pasture (plot 9) were 4,726 pounds in 1931; 2,578 pounds in 1932, and 4,300 pounds in 1933, or enough for 202, 110, and 184 cow-days of grazing, respectively.

The seasonal growth of the grass in the fertilized plucked plots is shown in figure 2, *A* and in the unfertilized plucked plots in figure 2, *B*.

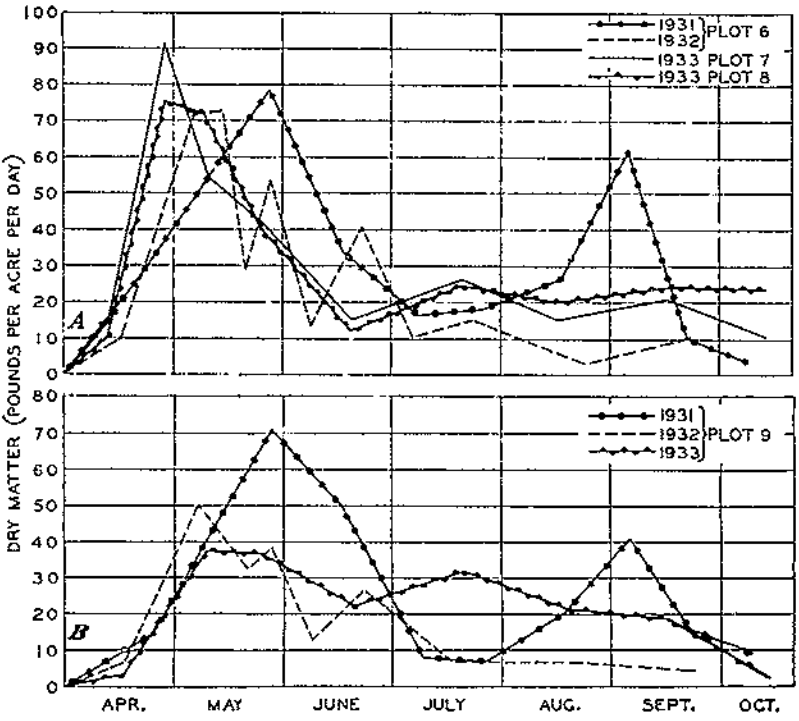

FIGURE 2.—Seasonal growth of grasses, as determined by plucking, at Beltsville, Md.: *A*, Fertilized Kentucky bluegrass pasture (plots 6, 7, and 8); *B*, unfertilized Kentucky bluegrass and lespedeza pasture (plot 9).

The influence of soil fertility on the seasonal growth of grass can be seen in figure 1 by comparing plot 1 with plots 2, 3, 4, and 5. The latter were similar to plot 1 except that they were more fertile due to the applications of manure. It will be noted that while the more fertile plots yielded heavier than the less fertile plot the seasonal growth followed the same trend in both instances.

Figure 2, *A* depicts the growth of a pasture that had received generous applications each year of a complete fertilizer. Some of the nitrogen was put on at intervals throughout the grazing season. Figure 2, *B* shows the growth of a similar pasture except that it was

not fertilized. A comparison of the two sets of graphs (fig. 2) shows that at Beltsville, under the usual climatic conditions, commercial fertilizers fail to improve the uniformity of growth.

These results agree very well with those reported by Vinall and Hein (*10*). In 1931 they found that the approximate monthly production of Kentucky bluegrass pasture, expressed in percentages of the total was as follows: April, 19; May, 28; June, 21.4; July, 18; and August, 13.6.

RESULTS[2] AT JEANERETTE, LA.

Four plots, varying in size from 1.19 to 1.69 acres, of grass pasture were clipped at regular intervals at the Iberia Livestock Experiment Station at Jeanerette, for the season of 1931. Plots 3A and 4A were clipped every 21 days, and plots 3B and 4B every 28 days. The principal plants in these plots were white clover, Bermuda grass, Dallis grass, Vasey grass, and carpet grass. The white clover was the predominating plant early in the season. Then after a period of comparative inactivity the grasses came on with the result that the production of dry matter was more rapid in the late summer and early fall than it was early in the season.

The precipitation (in inches) by months for the season of 1931 was as follows: March, 4.71; April, 1.17; May, 2.39; June, 2.02; July, 5.48; August, 6.07; September, 3.36; and October, 3.33. Table 4 shows the yields of dry matter per acre per day and the estimated carrying capacity of the four plots of grass.

TABLE 4.—*The yield of dry matter per acre per day and the estimated carrying capacity of four plots of grass pasture, clipped every 21 or 28 days, at Jeanerette, La., in 1931*

PLOTS CLIPPED EVERY 21 DAYS

Period of growth[1]	Plot 3A		Plot 4A	
	Dry matter per acre per day	Area required to support one milking cow	Dry matter per acre per day	Area required to support one milking cow
	Pounds	*Acres*	*Pounds*	*Acres*
Mar. 1 to May 5	8.3	2.8	7.6	3.1
May 5 to May 26	2.4	9.8	4.0	5.9
May 26 to June 16	.9	26.0	1.9	12.3
June 16 to July 7	.7	33.4	1.0	23.4
July 7 to July 28	4.0	5.9	3.2	7.3
July 28 to Aug. 18	7.4	3.2	8.7	2.7
Aug. 18 to Sept. 8	15.2	1.5	25.7	.9
Sept. 8 to Sept. 29	5.2	4.5	4.6	5.1

PLOTS CLIPPED EVERY 28 DAYS

	Plot 3B		Plot 4B	
Mar. 1 to May 5	5.5	4.3	6.7	3.5
May 5 to June 2	2.1	11.1	6.2	3.8
June 2 to June 30	1.0	12.3	5.2	4.5
June 30 to July 28	3.2	7.3	2.7	8.7
July 28 to Aug. 25	20.4	1.1	20.1	1.2
Aug. 25 to Sept. 22	16.3	1.4	13.2	1.8

[1] Growth assumed to start Mar. 1. The last day of each period of growth represents the date of clipping.

[2] The data were collected by S. L. Cuthcart, agent in dairying, Bureau of Dairy Industry, who is stationed at the Iberia Livestock Experiment Station, Jeanerette, La.

The total yield of dry matter per acre for the season on plot 3A was 1,303 pounds, on plot 4A 1,536 pounds, on plot 3B 1,588 pounds, and on plot 4B 1,769 pounds. These yields would provide nutrients for 56, 66, 68, and 76 cow-days respectively, or an average of 66 cow-days per acre. The plots clipped every 28 days yielded 18 percent more than those clipped every 21 days.

The seasonal growth of the grass on the four plots is shown in figure 3, *A*.

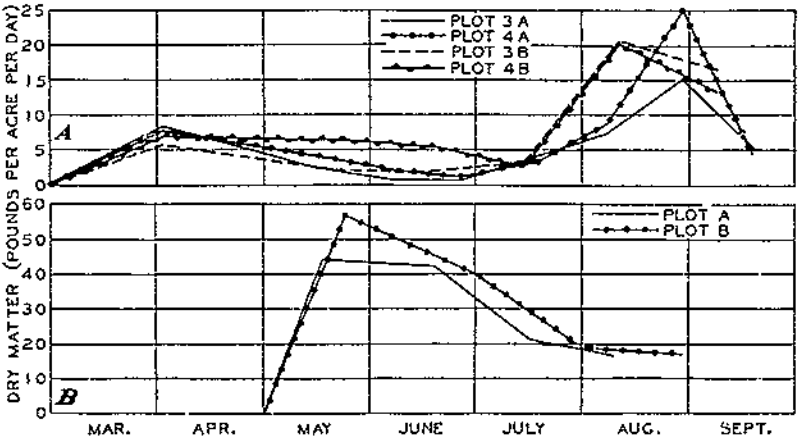

FIGURE 3.—Seasonal growth of grasses: *A*, Clover and pasture-grass mixture on 4 plots, 2 of them (3A and 4A) clipped at intervals of 21 days and 2 (3B and 4B) at intervals of 28 days, at Jeanerette, La., in 1931; *B*, 2 plots (A and B) of a pasture mixture consisting of awnless bromegrass, orchard grass, tall fescue, perennial ryegrass, Kentucky bluegrass, white clover, and alsike clover, clipped at intervals of 4 weeks at Huntley, Mont., in 1929.

RESULTS[1] AT HUNTLEY, MONT.

In 1929 at Huntley, Mont., two plots of pasture mixture (plots A and B) were clipped at intervals of about 4 weeks. This mixture consisted of awnless bromegrass, orchard grass, tall fescue, perennial ryegrass, Kentucky bluegrass, white clover, and alsike clover. As the pasture was irrigated several times during the season the precipitation was thought to be of no particular significance and for this reason it is not given here.

Table 5 shows the yield of dry matter per acre per day and the estimated carrying capacity of the two pasture plots.

TABLE 5.—*The yield of dry matter per acre per day and the estimated carrying capacity of two plots at Huntley, Mont., in 1929*

Plot A			Plot B		
Period of growth[1]	Dry matter per acre per day	Area required for one milking cow	Period of growth[1]	Dry matter per acre per day	Area required for one milking cow
	Pounds	*Acres*		*Pounds*	*Acres*
May 1 to June 3	44.5	0.5	May 1 to June 16	56.5	0.4
June 3 to July 2	42.3	.6	June 16 to July 17	38.0	.6
July 2 to July 28	21.1	1.1	July 17 to Aug. 15	18.5	1.3
July 28 to Aug. 21	16.9	1.4	Aug. 15 to Sept. 11	16.8	1.4

[1] Growth assumed to start May 1. The last day of each period of growth represents the clipping date.

[1] The data were collected by D. V. Kopland, assistant dairy husbandman, Bureau of Dairy Industry, stationed at the Huntley Field Station, Huntley, Mont.

Plot A yielded at the rate of 3,695 pounds of dry matter per acre for the season and plot B at the rate of 4,855 pounds. These amounts would provide the nutrients for 158 and 207 cow-days respectively, or an average of 183 cow-days.

The seasonal growth of the grass on the two plots (A and B) is shown in figure 3, *B*.

RESULTS[5] AT PUYALLUP, WASH.

Plots of Kentucky bluegrass, of Reed canary grass, and of pasture mixture composed of Italian ryegrass, perennial ryegrass, meadow fescue, tall oatgrass, seaside bent, orchard grass, rough-stalk meadow grass, timothy, and the clovers—red, white, and alsike—were clipped at intervals of about 2 weeks during the season of 1931 at the Western Washington Experiment Station at Puyallup, Wash. The pasture mixture was seeded in the fall of 1929.

Compared with the precipitation in the East and South in 1931 the rainfall was somewhat lighter, there being practically none in the months of July and August. Still the grass continued to make a good growth. Doubtless this was due partly to the high level of the water table and partly to the cool temperature which prevented the rapid evaporation of soil moisture. The mean temperature from March to October inclusive averaged about 7° lower than at Beltsville, Md., and about 17° lower than at Jeanerette, La.

Table 6 shows the yield of dry matter per acre per day and the estimated carrying capacity of Reed canary grass and of the pasture mixture at Puyallup in 1931.

TABLE 6.—*The yield of dry matter per acre per day and the estimated carrying capacity of Reed canary grass and of the pasture mixture at Puyallup, Wash., in 1931*

Period of growth[1]	Reed canary grass		Period of growth[1]	Pasture mixture (average of 2 plots)	
	Dry matter per acre per day	Area required to support one milking cow		Dry matter per acre per day	Area required to support one milking cow
	Pounds	*Acres*		*Pounds*	*Acres*
Mar. 1 to May 23	39.2	0.6	Mar. 1 to May 10	32.4	0.7
May 23 to June 20	61.2	.4	May 10 to May 23	67.9	.3
June 20 to July 6	50.7	.4	May 23 to June 8	46.2	.5
July 6 to July 21	49.3	.5	June 8 to June 21	45.2	.5
July 21 to Aug. 7	53.4	.4	June 21 to July 3	54.6	.4
Aug. 7 to Aug. 20	41.4	.6	July 3 to July 15	61.9	.4
Aug. 20 to Sept. 1	32.2	.7	July 15 to July 28	42.8	.5
			July 28 to Aug. 12	42.4	.6
			Aug. 12 to Aug. 26	46.2	.6
			Aug. 26 to Sept. 9	51.7	.5

[1] Growth assumed to start Mar. 1. The last day of each period of growth represents the clipping date.

The yield of dry matter for the season was 8,571 pounds per acre for the Reed canary grass and 8,302 pounds per acre for the two plots of the pasture mixture. These yields would provide nutrients for 366 and 359 cow-days, respectively.

[5] The data were collected by R. E. Hodgson, agent, Bureau of Dairy Industry, U. S. Department of Agriculture, dairy husbandman, Western Washington Experiment Station, and assistant in dairy husbandry, Washington Agricultural Experiment Station.

Table 7 shows the yield of dry matter per acre per day and the carrying capacity of Kentucky bluegrass and the pasture mixture (clipped every 2 weeks) from February to November, inclusive, at Puyallup in 1931.[6]

TABLE 7.—*The yield of dry matter per acre per day and the estimated carrying capacity of Kentucky bluegrass and of a pasture mixture at Puyallup, Wash., in 1931*

Period of growth [1]	Kentucky bluegrass		Pasture mixture	
	Yield of dry matter per acre per day	Area required to support one milking cow	Yield of dry matter per acre per day	Area required to support one milking cow
	Pounds	*Acres*	*Pounds*	*Acres*
February	5.2	4.5	3.8	6.2
March	25.7	.9	10.4	1.4
April	47.0	.5	40.6	.6
May	40.8	.6	43.0	.5
June	41.5	.6	42.3	.6
July	53.8	.4	40.5	.5
August	21.3	1.1	20.8	1.1
September	40.2	.6	32.3	.7
October	19.0	1.2	15.1	1.5
November	3.6	6.5	5.2	4.5

[1] Clippings were made every 2 weeks.

The yield of dry matter for the pasture mixture was 8,114 pounds per acre, and the yield for the bluegrass was 9,097 pounds per acre, or enough for 347 cow-days on the pasture mixture and 389 cow-days on the bluegrass.

These yields at Puyallup exceed those at any of the other stations from which reports have been obtained except at Baton Rouge, La. Seasonal growth of the grass on the different plots is shown in figure 4. The uniformity of growth throughout the season should be noted.

RESULTS[7] AT OTHER STATIONS

The seasonal growth of grass has been determined by other investigators at several experiment stations in much the same way as was done at the stations of the Bureau of Dairy Industry. Most of these results have been published, and although they have not been translated into equivalent carrying capacity, they are included in graphic form in this bulletin to show the seasonal variations in pasture growth in regions not covered by data from the Bureau's stations. Aside from the graphs the only use made of the results at these other stations is to show the ranges of variation in the final discussion.

Figures 5 to 8, inclusive, show the seasonal growth of pasture grasses in experimental plots at Burlington, Vt., Ithaca, N. Y., State College, Pa., Blacksburg, Va., Clemson College, S. C., Baton Rouge, La., Ottawa, Canada, and Cambridge, England.

[6] The data were collected by M. S. Grunder, agronomist, Western Washington Experiment Station, Puyallup, Wash.

[7] The data for this discussion were taken from various experiment station publications (*2, 4, 7, 9, 11, 12, 13*) and from unpublished reports received from W. B. Ellett, chemist, Virginia Agricultural Experiment Station, and R. H. Lush, research professor in dairy production, Louisiana Agricultural Experiment Station.

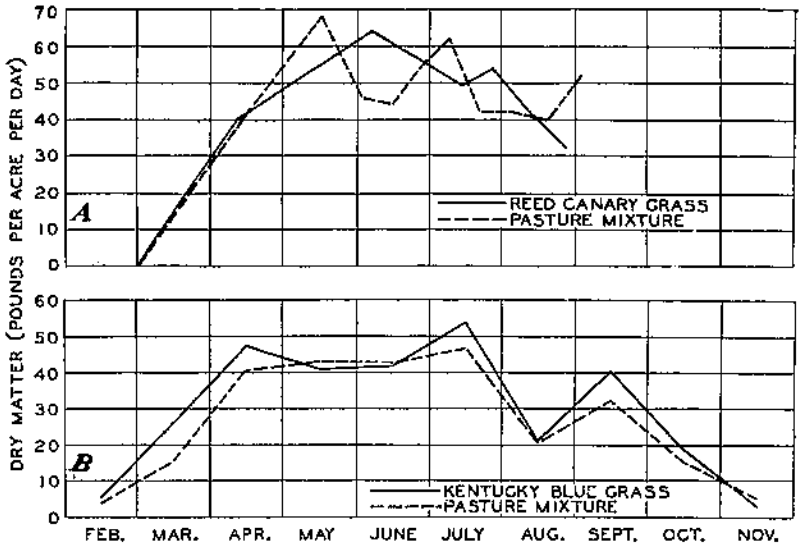

FIGURE 4.—Seasonal growth of grasses at Puyallup, Wash., in 1931: *A*, Reed canary grass and pasture mixture; *B*, Kentucky bluegrass and pasture mixture.

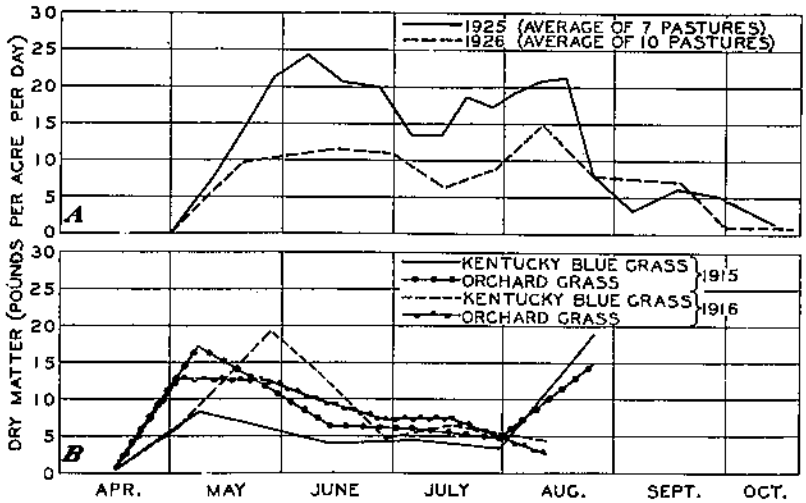

FIGURE 5.—Seasonal growth of grasses: *A*, Native grass pastures at Burlington, Vt.; *B*, Kentucky bluegrass and orchard grass at Ithaca, N. Y.

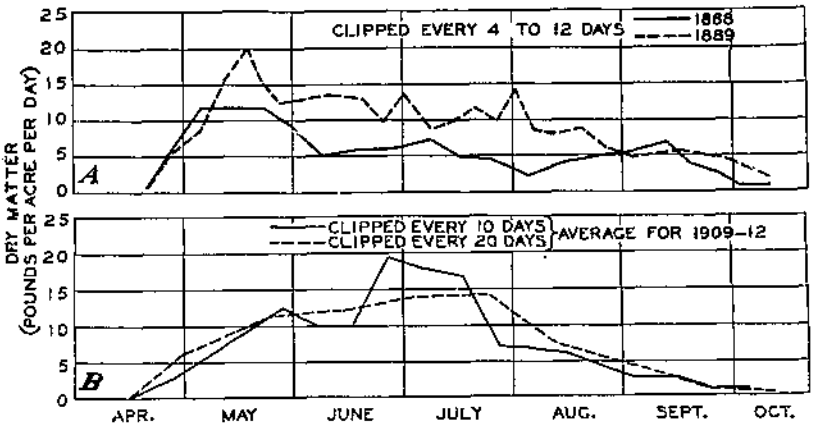

FIGURE 6.—Seasonal growth of Kentucky bluegrass: *A*, Clipped every 4 to 12 days at State College, Pa., in 1888 and 1889; *B*, average of 4 seasons (1909–12) at Blacksburg, Va.

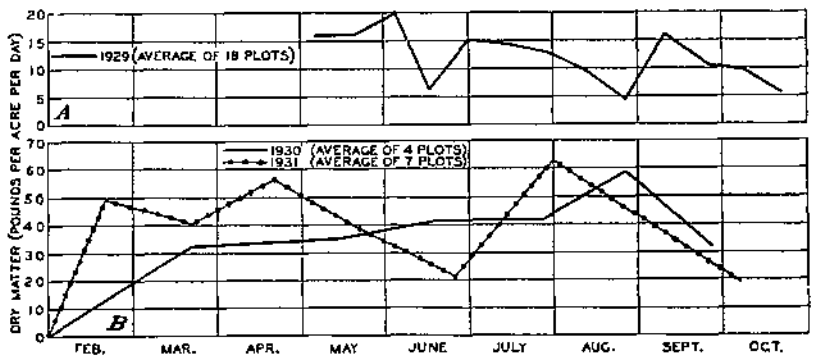

FIGURE 7.—Seasonal growth of grasses; *A*, Bermuda grass clipped every 2 weeks at Clemson College, S. C.; *B*, pasture mixture at Baton Rouge, La.

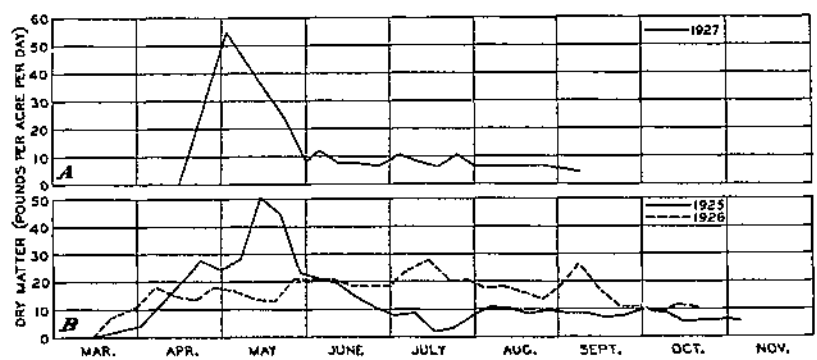

FIGURE 8.—Seasonal growth of grasses: *A*, Meadow foxtail at Ottawa, Canada; *B*, pasture mixture clipped every 7 days at Cambridge, England.

From the yields of dry matter per acre per day, the carrying capacity of the different pastures reported in this study has been computed for each month of the grazing season. Table 8 shows the seasonal range in carrying capacity as indicated by the area required to support one milking cow during the month the pasture was at its best and the month it was at its poorest.

TABLE 8.—*Range in carrying capacity of the various pastures as indicated by the area required to support one milking cow during the month the pasture was at its best and the month it was at its poorest*

Station	Crop	Plot no.	Year	Carrying capacity when pasture was—			
				Best		Poorest	
				Month	Area required per cow	Month	Area required per cow
					Acres		*Acres*
Beltsville, Md.	Kentucky bluegrass, orchard grass, and white clover	1	1929	May	1.6	August	22.9
			1931	August	1.5	July	2.6
			1932	May	1.1	August	15.7
			1933	do	.8	July	2.4
		2	1932	do	.9	August	12.3
			1933	do	.8	July	1.8
	Kentucky bluegrass, orchard grass, and redtop	3	1933	do	.8	do	1.4
		4	1931	do	.8	do	2.1
	Reed canary grass	5	1931	do	1.4	do	2.6
	Kentucky bluegrass	6	1931	do	.5	do	1.3
			1932	do	.4	August	6.9
		7	1933	do	.4	do	1.4
		8	1933	do	.4	June	1.5
	Kentucky bluegrass and lespedeza	9	1931	June	.5	July	3.2
			1932	May	.6	August	3.7
			1933	do	.7	April	6.7
Jeanerette, La.	Pasture mixture	3A	1931	August	2.1	June	28.9
		4A	1931	do	1.5	do	15.8
		3B	1931	do	1.2	do	12.2
		4B	1931	do	1.2	July	5.3
Huntley, Mont.	do	A	1929	May	.5	August	1.4
		B	1929	do	.4	do	1.3
Puyallup, Wash.	Reed canary grass		1931	June	.4	do	.6
	Pasture mixture		1931	May	.5	do	.5
	do		1931	July	.5	do	1.1
	Kentucky bluegrass		1931	do	.4	do	1.1
Burlington, Vt.	Native pasture		1925	June	1.1	September	5.1
	do		1926	do	2.1	do	4.0
Ithaca, N. Y.	Kentucky bluegrass		1915	May	2.9	July	5.7
	do		1916	June	2.1	August	5.3
	Orchard grass		1915	May	1.4	July	4.2
	do		1916	do	1.9	August	8.7
State College, Pa.	Kentucky bluegrass		1888	do	2.1	do	6.3
	do		1889	do	1.7	September	4.8
	do		1909	June	1.2	do	7.3
Blacksburg, Va.	do		1910	July	.9	do	8.6
	do		1911	June	2.5	do	18.4
	do		1912	May	3.4	do	16.1
Clemson College, S. C.	Bermuda grass		1929	do	1.4	do	2.9
Baton Rouge, La.	Pasture mixture		1930	August	.4	March	.7
	do		1931	April	.4	June	1.0
Ottawa, Canada	Meadow foxtail		1927	May	.6	August	3.6
Cambridge, England	Pasture mixture		1925	do	.7	July	4.0
	do		1926	July	1.0	April	1.5
Average					1.1		6.0

The pastures varied tremendously in total yield of dry matter per acre for the season. The lowest yield was 710 pounds per acre and the highest was 10,124 pounds per acre. The lowest yield provided enough feed for 30 cow-days, the highest enough for 433 cow-

days. The average yield for the 12 places represented in the study was 3,486 pounds, or enough for 149 cow-days.

The amount of nutrients provided by an acre of the lowest yielding pasture would have been contained in 949 pounds of alfalfa hay; by an acre of the highest yielding pasture, in 13,538 pounds of alfalfa; and by an acre of the average pasture, in 4,662 pounds of alfalfa. On the whole, these pastures yielded very well and were probably much above the average.

The total yield varied not only with the different pastures and places but also from year to year on the same pasture. Two extreme examples are as follows: A plot at Beltsville, Md., yielded enough for 56 cow-days in 1929 and enough for 113 cow-days in 1933; two plots at Blacksburg, Va., yielded over twice as much in 1910 as they did in 1911.

DISCUSSION

As a rule the greatest growth of grass at the various places took place early in the grazing season, except at the two stations in Louisiana. The heavy growth in August in Louisiana was probably due partly to the generous rainfall during that month and partly to the presence of Bermuda grass and crabgrass. These grasses have the habit of making most of their growth in the latter part of the season.

At Beltsville, in 1929, the yield was 13 times as much for the month of May as for the month of August. At Jeanerette, La., in 1931, the yield was 14 times as much in August as in June. On the other hand, at Beltsville, in 1931, one pasture yielded only 1.7 times as much during the best month as it did during the poorest month. At Puyallup, Wash., in 1931, one pasture yielded almost the same in the poorest month as in the best month. At Cambridge, England, in 1926, one pasture yielded only 1.5 times as much in the best as in the poorest month. The average yield of the 44 pastures was over five times as much in the best month as in the poorest month. Only 3 or 4 of the 44 pastures yielded uniformly enough so that a herd of cows could be maintained on a given area throughout the season without the grass becoming either too mature or too short.

The range in carrying capacity depends to a large extent upon the water content of the soil and this in turn is influenced by the amount of rain that soaks into the ground, and by atmospheric conditions affecting the rate of evaporation. No doubt the relatively uniform growth of grass in England is due to the gentle rains, cool temperatures, and cloudy weather. Reports show a summer rainfall there that would be considered low over much of the United States. The uniform growth of grass at Puyallup, Wash., can likewise probably be explained by the high level of the water table and the cool weather, for there, too, the summer rainfall was light. At Beltsville, also, there are times in late summer after generous rains when the growth may be as rapid as in the spring. The amount of soil moisture seems to affect the growth more than any other factor.

The kinds of plants growing in the pasture also have an influence on the seasonal growth. For example, Kentucky bluegrass, orchard grass, and ryegrass, under usual conditions, make the greater part

of their growth early in the season; the lespedezas, Bermuda grass, and crabgrass make most of their growth later in the season. A mixture of early- and late-growing plants will make the seasonal growth of the pasture more uniform than will the presence of either early- or late-growing plants by themselves. The uniformity of growth at Baton Rouge, La., is due largely to the presence of both early- and late-growing plants. Probably there is a tendency, however, to overemphasize the influence of the habits of the plants. While it is true that Kentucky bluegrass, for instance, does make its greatest growth early in the season as a rule, the results at Puyallup, Wash., show that under favorable conditions this grass continues to grow well throughout the season. The so-called "dormant period" of bluegrass may be due not so much to the nature of the plant as to the scarcity of soil moisture.

The results at Beltsville show that neither the fertility of the soil nor the application of complete fertilizers materially affects the uniformity of growth throughout the season under the conditions prevailing there but they do, of course, affect the total yields.

Since it is evident that there is no practical way to make a permanent pasture produce uniformly throughout the season nor the same in one season as in another (except perhaps in regions where irrigation is feasible), the dairyman must be prepared to supplement his pastures at some time or other during the grazing season.

In view of the beneficial effects of pasture grass and other green forage upon the nutrition of the dairy cow, and the economic advantage of growing and feeding pasture and forage crops,[8] it would be highly desirable to remedy the shortcomings of permanent pastures by supplementing them with some other green crop or crops. On farms where grasses or a mixture of grasses and clover are raised for hay the hayfields can be pastured after the hay is cut. On other farms Sudan grass, sweetclover, or soybeans may be used for a temporary pasture. In the central and southern part of the United States improved varieties of lespedeza show much promise as crops for temporary pastures. As the extent to which supplementary pasture will be needed may be uncertain it appears good practice to raise crops for supplementary pasture which can be made into an acceptable hay in case they are not all utilized for grazing.

Soiling crops or crops that can be cut and fed green will supplement the permanent pastures very nicely. The objection to their use is the labor involved in harvesting them and in getting them to the cows. Crops that are raised regularly should be used for soiling where possible, instead of planting special crops. This will avoid interference with the regular system of cropping. Part of the second and third cuttings of alfalfa, part of the soybeans or Sudan grass, and part of the crop of corn or sorghum, can be cut and fed

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[8] GRAVES, R. R., and SHEPHERD, J. B. A STUDY OF CERTAIN PHASES OF THE ECONOMICS OF DAIRY-CATTLE FEEDING. Bur. of Dairy Indus., Roughage Feeding Series 1, BDIM–625, U. S. Dept. Agr., 1933. [Mimeographed.]

UNITED STATES DEPARTMENT OF AGRICULTURE, BUREAU OF DAIRY INDUSTRY. ROUGHAGE RATIONS FOR DAIRY COWS MAKE LESS MILK AND MORE PROFIT. U. S. Dept. Agr., Bur. of Dairy Indus., Roughage Feeding Series 2, BDIM–626. 1934. [Mimeographed.]

GRAVES, R. R., and SHEPHERD, J. B. A STUDY OF THE EFFECT OF MODIFIED SYSTEMS OF FARMING ON MILK PRODUCTION AND NET RETURNS OVER CASH OUTGO FOR PURCHASED FEEDS. U. S. Dept. Agr., Bur. Dairy Indus., Roughage Feeding Series 3, BDIM–627. 1934. [Mimeographed.]

green. On small farms much of this "soiling" may often be done merely by cutting some of the crop and throwing it over the fence into the pasture.

Another method of supplementing the pastures during periods of slack growth is to keep the cattle off a portion of the pasture during the season of greatest growth, so that hay can be made from the ungrazed portion and fed when the pasture becomes short. Or this surplus grass may be made into silage instead of hay. Grass silage is used successfully in several foreign countries.

In view of the cost and the uncertainty of temporary pastures, as well as the trouble and expense of using soiling crops, it seems that the cheapest way to supplement permanent pastures might be with hay and silage, such as is fed in the winter. However, it is possible that the more perfect nutrition of the cows with respect to vitamins and minerals when fed green crops would counterbalance any saving in expense that might be effected by feeding hay and silage, especially if the hay has a poor color.

The Bureau of Dairy Industry has conducted a number of investigations which have a bearing on the problem of utilizing pasture and pasture plants advantageously, and other studies are under way. For example, rotation grazing, digestibility of pasture grass (*6*, *15*), and methods of making grass silage have and are now receiving attention at the Puyallup, Wash., and the Beltsville, Md., stations. The utilization of the surplus pasturage as hay and silage has been investigated at Huntley, Mont. (*5*), and further work is under way there and at Puyallup, Beltsville, and Lewisburg, Tenn. At Woodward, Okla., Sudan-grass pasture has been compared with hay and silage from the same crop (*3*). Other work includes the influence of fertilizers, the carrying capacity of pastures (*8*), supplementing pasturages with hay or silage made from pasture grass, and annual crops to use for supplementing permanent pastures. Some of this work is being done in cooperation with the Bureau of Plant Industry.

SUMMARY

The growth of grass in pastures is not uniform throughout the grazing season. Since there is no practical way to make a permanent pasture produce uniformly throughout the season nor the same in one season as in another, the dairyman must be prepared to supplement his pastures at some time or other during the grazing season.

The data presented in this bulletin show the seasonal and yearly variations in pasture growth at 12 different experiment stations, also the estimated carrying capacity of the pastures for the different months of the grazing season for the years studied.

The total yield of dry matter per acre varied tremendously, not only with the different pastures and localities but also from year to year on the same pasture. As a rule, however, the greatest growth of grass at the various stations occurred early in the growing season.

The information presented here is intended to show in a general way when pastures may be expected to be inadequate, thus making possible a more intelligent consideration of methods for supplementing short pastures or for utilizing surplus pasture growth.

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