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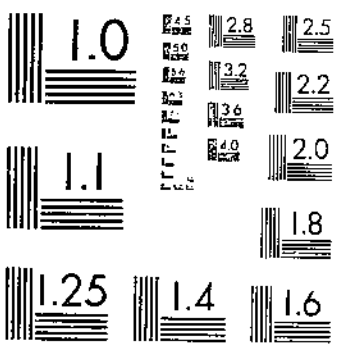

MICROCOPY RESOLUTION TEST CHART
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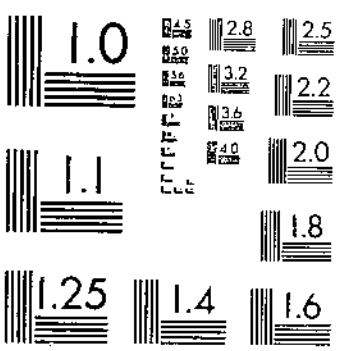

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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SUDAN GRASS AS HAY, SILAGE, AND PASTURE FOR DAIRY CATTLE

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CONTENTS

INTRODUCTION

Sudan grass is an important hay and pasture crop of the Middle West and Southwest because it is drought and heat resistant. It makes its greatest growth and produces the most feed during July, August, and September, when native grasses are less productive.

The usual farm practice in making Sudan-grass hay is to cut it when the seeds in the heads are in the milk or soft-dough stage. One and sometimes two cuttings, depending on the season, are obtained when the hay is cut at this stage. This procedure results in a coarse, stemmy hay, and dairy cattle refuse to eat probably 25 per cent of it by weight. Considerable information has heretofore been available on the comparative yields of Sudan-grass hay cut at different stages of maturity,[1] [2] but data indicating the comparative feeding value for dairy cattle are limited.

Previous experiments with Sudan grass at the Woodward station [3] have shown that as pasture it exceeded winter wheat, winter rye, and

[a] The work of the Woodward Dairy Experiment Station is carried on by the Bureau of Dairy Industry in cooperation with the Oklahoma Agricultural and Mechanical College. Specialists of the Bureau of Plant Industry, on the staff of the Dry Land Experiment Station, at Woodward, Okla., rendered advice on the stages for cutting the hay. Charles B. Parker, junior chemist, Bureau of Dairy Industry, conducted the analytical work.

[1] VINALL, H. N. SUDAN GRASS. U. S. Dept. Agr. Farmers' Bul. 1126, 21 p., 10 fig., 1931.

[2] VINALL, H. N., and GETTY, R. E. SUDAN GRASS AND RELATED PLANTS. U. S. Dept. Agr. Bul. 981, 68 p., 25 fig. 1921. (This bulletin contains a detailed account of the introduction of Sudan grass and several other species of grass sorghums, as well as a summary of the results of numerous experiments with Sudan grass in the United States.)

[3] STAUBER, C. J., STUART, D., and GRAVES, R. R. DAIRY WORK AT THE WOODWARD FIELD STATION, WOODWARD, OKLA., 1921 to 1926. U. S. Dept. Agr. Circ. 12, 24 p., illus. 1927.

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sweetclover in nutrients produced and value per acre. As a hay crop it exceeded cowpeas in yield and nutrients produced per acre, but was exceeded by Sunrise kafir and Red Amber sorgo in yield and nutrients produced per acre.

FIGURE 1.—Sudan-grass hay cut at three stages of maturity: A, first-heads-out stage; B, full-head stage C, milk or soft-dough stage

PLAN OF INVESTIGATIONS

In 1928 experiments were started at the Woodward (Okla.), Dairy Experiment Station to compare the yields of nutrients per acre and to compare the feeding values for milk production of Sudan-grass hay

harvested (1) when heads first appeared, (2) when fully headed, and (3) when the seeds were in the milk or soft-dough stage. Field records have been secured for three years (1928 to 1930, inclusive), on the full-head and soft-dough stages and for four years (1928 to 1931, inclusive), on the first-heads-out stage. For two years (1929 and 1930) data were secured on the yields of Sudan-grass hay cut approximately every 30 days. Feeding experiments comparing the feeding values of the hay made from the various stages were conducted for the two years 1928 and 1929, and in addition, for the years 1929 and 1931, respectively, Sudan grass cut in the full-head and first-heads-out stages was ensiled, and groups of cows were fed in such manner as to obtain a comparison of the hay and the silage both made at the full-head and first-heads-out stages.

Additional data were secured in 1928 to 1931, inclusive, on the carrying capacity and milk production per acre for Sudan grass as a pasture crop, and these data are included and are interpreted on a comparative basis with the yields and nutrients produced by Sudan grass as a hay crop

FIELD EXPERIMENTS WITH SUDAN GRASS CUT AT DIFFERENT STAGES OF MATURITY

For these experiments similar plots of land of approximately 0.675 acre each were laid out and seeded (drilled) to Sudan grass. The seeding date was June 1 for 1928 and 1929, May 22 for 1930, and June 8 for 1931, and the seed was sown at the rate of 12 pounds per acre. The plots had received no fertilizer treatment and were comparable in every way. The hay was cut at the stages previously mentioned, unless otherwise noted (fig. 1), allowed to cure in the field, and then cocked for several days, after which it was carefully weighed and stacked. The weights obtained when the hay was stacked were considered as field-cured weights.

TABLE 1.—*Comparison of yields of Sudan-grass hay from similar plots cut at three different stages of maturity, 1928*

Item	Stage		
	First heads out	Fully headed	Milk or soft dough
Date of seeding	June 1	June 1	June 1
Date of—			
First cutting	July 19	Aug. 3	Aug. 15
Second cutting	[1] Oct. 5	[1] Oct. 5	[1] Oct. 5
Length of time between—			
Sowing and first cutting ..... days	48	63	75
First and second cuttings ..... do	[1] 78	[1] 63	[1] 51
Field-cured hay (weight as stacked):			
First cutting ..... pounds per acre	3,409	4,180	4,217
Second cutting ..... do	1,245	709	226
Total field-cured hay ..... do	4,654	4,889	4,443
Total air-dry hay [2] ..... do	3,723	3,911	3,554

[1] On account of an unfavorable growing season, this cutting did not represent the stage indicated. Second cuttings were all made on the same date.

[2] Calculated on the basis of loss of 20 per cent in moisture. This is the average loss for 1930.

Representative samples of each cutting were obtained at the time of weighing and stacking. The samples were placed in muslin bags and were hung up to dry until they were thoroughly air-dry. Yields of air-dry hay per acre were calculated from the loss in weight of the samples from the field-cured to the air-dry basis. For 1928, only the field-cured weight was obtained, but the air-dry weight was calculated from the loss in weight of the samples for 1930. The air-dry samples were sent to the Washington, D. C., laboratory for chemical analyses.

Tables 1 and 2 give the essential field records on the hay cut at the indicated stages for 1928 to 1930.

TABLE 2.—*Comparison of yields of Sudan-grass hay from similar plots cut at four different stages of maturity in 1929 and 1930*

Item	Stage			
	First heads out		Full head	
	1929	1930	1929	1930
Date of seeding	June 1	May 22	June 1	May 22
Date of—				
First cutting	July 17	July 8	July 31	July 19
Second cutting	Aug. 28	Aug. 14	Oct. 21	Oct. 9
Third cutting	Oct. 21	Oct. 9		
Fourth cutting				
Length of time between—				
Sowing and first cutting—days	46	47	60	58
First and second cuttings—do	42	37	82	82
Second and third cuttings—do	54	56		
Third and fourth cuttings—do				
Air-dry hay:				
First cutting—pounds per acre	2,492	1,739	2,908	1,952
Second cutting—do	970	317	1,932	1,072
Third cutting—do	1,710	1,147		
Fourth cutting—do				
Total air-dry hay—do	5,172	3,203	4,840	3,024

Item	Stage			
	Milk or soft dough		Cut every 30 days	
	1929	1930	1929	1930
Date of seeding	June 1	May 22	June 1	May 22
Date of—				
First cutting	Aug. 10	July 30	July 5	June 30
Second cutting	[1] Oct. 21	Oct. 9	Aug. 5	Aug. 8
Third cutting			Sept. 10	Sept. 12
Fourth cutting			Oct. 10	Oct. 20
Length of time between—				
Sowing and first cutting—days	70	69	34	30
First and second cuttings—do	[1] 72	71	31	39
Second and third cuttings—do			36	35
Third and fourth cuttings—do			30	38
Air-dry hay:				
First cutting—pounds per acre	3,483	2,021	689	1,296
Second cutting—do	[1] 1,648	1,061	1,334	810
Third cutting—do			437	846
Fourth cutting—do			583	240
Total air-dry hay—do	5,131	3,082	3,043	3,192

[1] This cutting did not quite reach the full-milk or soft-dough stage.

In 1929, the second cutting from the plot used for the soft-dough-stage hay did not quite reach that stage. The 30-day-stage hay in

1930 represented a somewhat longer growing period than 30 days, the four cuttings averaging 38 days' growth. For 1929 the four cuttings of 30-day-stage hay averaged 33 days in growth. For convenience, however, it is hereafter referred to as 30-day-stage hay.

The difference in growth as represented by the number of cuttings for the three respective years is explained by the amount of rainfall during the growing period for those years. This is shown in Table 3.

TABLE 3.—*Record of rainfall during 5-month growing period, Woodward, Okla., 1928 to 1931, inclusive*

Year	Rainfall (inches)					
	May	June	July	August	September	Total for 5 months
1928	6.09	3.74	1.42	0.35	0.81	13.01
1929	3.41	.58	3.15	2.09	4.45	13.68
1930	7.78	2.93	.23	1.42	1.06	13.42
1931	3.44	2.69	1.13	1.53	2.86	11.65

July, August, and September are the three months when rain is most needed for recovery and growth after cutting. For this reason the yields of hay in 1929 are materially higher than the yields in 1928 and 1930.

Records were kept for 1931 on the yields of Sudan-grass hay cut at first-heads-out stage only and are as follows:

Seeded	[4] May 29
First cutting	July 22
Second cutting	Sept. 2
Third cutting	Oct. 22
Days between reseeding and first cutting	44
Days between first and second cuttings	42
Days between second and third cuttings	50
Air-dry hay per acre, first cutting (pounds)	1,239
Air-dry hay per acre, second cutting (pounds)	499
Air-dry hay per acre, third cutting (pounds)	833
Total air-dry hay per acre (pounds)	2,571

The yield of 2,571 pounds of air-dry hay per acre in three cuttings is considerably lower than that of the hay cut in the three previous years at the same stage. The fact that this yield was lower was due largely to a shortage of moisture. In 1931 the rainfall was only 11.65 inches for the five months May to September, inclusive, while in each of the three years previous, the rainfall slightly exceeded 13 inches for these months. Then too, in 1931 the Sudan grass had to be reseeded. It was originally planted on May 29, but 1.9 inches of rain fell on June 5 and washed out most of the seed.

The yields of hay from the different stages of maturity are surprisingly close by years. Judging by the yields in the three years in which hay of the three stages of maturity was made, there is no material difference in the acre yields of air-dry hay. For these three years the average yield per acre was 4,033 pounds of first-heads-out hay, 3,925 pounds of fully headed hay, and 3,922 pounds of soft-dough-stage hay. The average yield of hay cut approximately every 30 days during 1929 and 1930 was 3,117 pounds. This is considerably lower than the 3-year average for the hay cut at the other three stages

[4] Reseeded June 8.

of maturity. In 1929 the yield of the hay cut every 30 days was markedly lower, but in 1930 it was practically the same as that for the other three stages. These yields are somewhat lower but compare favorably with yields of Sudan-grass hay reported from the Fort Hays Experiment Station, Hays, Kans.[6]

As previously stated, the hay was weighed as taken from the field before it was made into small stacks of approximately 3 tons. From the difference between the weight of the hay as taken from the field, its weight on an air-dry basis, and the amount of moisture remaining in the air-dry sample, the moisture content of the field-cured hay was calculated. These results indicate that some of the cuttings went into the stack containing as high as 46 per cent moisture. This is much higher than is ordinarily considered safe for stacking or placing in the mow. With the exception of a small amount of the second cutting from the first heads-out plot for 1929 the hay was not damaged by heating. No browning of the hay, such as would occur in "tobacco-cured" alfalfa was noted.

CHEMICAL COMPOSITION AND PROTEIN CONTENT

The chemical composition of the hays cut at the different stages in 1928, 1929, and 1930 is given in Table 4.

In two of the three years the percentage of crude protein in the first cutting was materially greater for the hay cut at the first-heads-out stage than for the full-head and soft-dough stages, but in 1930, the hay cut at the full-head stage was somewhat higher in crude protein. Due to the short growing season in 1928 the Sudan grass, after the first cutting on July 19, did not reach the stage of maturity desired before danger of frost was imminent. Consequently, the second cutting on all three plots was made on October 5.

In 1928 the period between the time of first cutting and the date, October 5, when the Sudan grass on all three plots was cut, was 51 days for the soft-dough plot; 63 days for the full-head plot, and 78 days on the first-heads-out plot. (Table 1.) In periods of time for growth the plots were actually reversed from what they were at the time of the first cutting. While days' growth is not always a criterion of stage of growth reached, in this instance both the crude-protein and crude-fiber content follow very closely the days' growth in reverse order, the hay being highest in protein content and lowest in crude fiber for the 51 days' growth (second cutting, soft-dough stage, 1928) and lowest in percentage of protein and highest in crude fiber for the 78 days' growth (second cutting, first heads out, 1928).

In 1929 three cuttings were obtained on the plot cut when first headed out. The soft-dough plot, cut first on August 10 (Table 2), again failed to reach the soft-dough stage when growth stopped on October 21. Consequently the hay on this plot represented a shorter period of growth at the second cutting (72 days) than did the hay from the full-head plot (82 days). The effect of stage of maturity is again reflected, as it was in the 1928 cuttings, in the crude-protein and crude-fiber content following the period of growth, but in reverse order. The protein content decreased as the period of growth advanced, while the crude-fiber content increased. The period of growth at the time of the second cuttings on the full-head and soft-dough plots was longer in 1929 than in 1928, yet the percentage of

[6] VINALL, H. N. SUDAN GRASS. U. S. Dept. Agr. Farmer's Bul. 1126. p. 13, 1931.

TABLE 4.—*Chemical composition of Sudan-grass hay (dry-matter basis) cut at different stages of maturity and yields of dry matter and crude protein, 1928–1930*

Year and stage of maturity	Composition of each cutting																Yield per acre of—	
	Crude protein in—				Ether extract (fat) in—				Crude fiber in—				Nitrogen-free extract in—					
	First	Second	Third	Fourth	First	Second	Third	Fourth	First	Second	Third	Fourth	First	Second	Third	Fourth	Dry matter[1]	Crude protein
1928	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Pounds*	*Pounds*
First heads out	12.5	6.8	------	------	2.10	1.37	------	------	30	34	------	------	47	50	------	------	3,351	367.6
Full head	8.5	6.9	------	------	1.59	1.48	------	------	34	32	------	------	47	51	------	------	3,525	291.0
Soft dough	5.8	8.5	------	------	1.57	1.58	------	------	34	30	------	------	52	52	------	------	3,199	195.0
1929																		
First heads out	13.4	12.4	10.7	------	1.33	2.01	1.85	------	33	28	30	------	40	45	46	------	4,655	573.5
Full head	8.3	10.3	------	------	1.93	1.77	------	------	32	31	------	------	50	47	------	------	4,356	396.3
Soft dough	8.0	11.8	------	------	1.92	1.74	------	------	35	29	------	------	49	41	------	------	4,618	425.7
Cut every 30 days	14.2	9.4	14.7	16.7	1.12	2.45	2.23	1.58	19	28	29	27	27	51	43	37	2,739	344.0
1930																		
First heads out	9.5	11.3	8.6	------	2.16	2.39	1.21	------	29	26	30	------	52	53	47	------	2,883	269.7
Full head	10.6	8.3	------	------	2.11	1.54	------	------	26	33	------	------	53	49	------	------	2,722	266.3
Soft dough	7.8	9.6	------	------	1.97	1.66	------	------	30	30	------	------	55	49	------	------	2,774	233.5
Cut every 30 days	12.7	10.8	17.2	(2)	2.31	2.28	2.32	(2)	27	19	25	(2)	50	46	42	(2)	2,873	383.2

[1] Air-dry hay averaged 10 per cent moisture.
[2] No sample.

protein was higher for the hay cut from these plots in 1929, and the percentage of crude fiber was lower. This would seem to be contradictory to the results that have just been pointed out as due to length of period of growth. It has been found, however, that the absence of moisture will also affect these elements, prolonged dry weather depressing the percentage of protein. The rainfall was very light in August and September in 1928 and was much heavier in the same months in 1929. This would probably account for the greater percentage of protein in the second cuttings in 1929 notwithstanding the longer period of growth, as compared with the second cuttings in 1928. Other conditions might have been responsible for retarding the maturation of the plants in 1929.

The average crude-protein content for the three years of the three respective stages for first cuttings only is:

	Per cent
First heads out	11.8
Full head	9.1
Soft dough	7.2
Cut every 30 days (1929 and 1930 only)	13.5

The hay cut every 30 days was higher in crude protein in 1929 than the first heads out and other stages, in all but the second cutting, which contained only 9.4 per cent of crude protein. Since the crude-fiber content of this cutting was low, it is probable that the sample analyzed was not typical. The average crude-protein content of the four 30-day cuttings for 1929 was 13.6 per cent.

In 1930 the hay from the first three cuttings of the 30-day hay averaged 13.6 per cent protein, the same as did the four cuttings for 1929. In 1930 the 30-day hay averaged 37 days' growth, while in 1929 it averaged only 33 days' growth.

Table 5 was compiled to show more clearly the relation of the chemical composition of the Sudan-grass hay to the number of days' growth. This table shows the average composition of all samples analyzed, arranged approximately by 10-day growth periods at time of cutting, which ranged from 30 to 82 days.

TABLE 5.—*Average composition of Sudan-grass hay arranged according to 10-day growth periods, dry-matter basis*

Days of growth	Samples of hay analyzed	Nutrients			
		Crude protein	Ether extract (fat)	Crude fiber	Nitrogen-free extract
	Number	*Per cent*	*Per cent*	*Per cent*	*Per cent*
30 to 40	8	13.3	2.08	31	44
41 to 50	4	11.9	1.90	30	46
51 to 60	4	9.6	1.69	29	49
61 to 70	4	7.9	1.74	32	51
71 to 82	7	8.7	1.65	32	48

The percentage of protein decreased with advance in days' growth, as was to be expected, except in those samples representing a growth of 71 days and over, which are a little high. The ether extract (fat) also decreased consistently with advance in number of days' growth. The crude-fiber content for the two periods of 30 to 40 days and 41 to 50 days is higher than was to be expected, in view of the percent-

ages shown for the last three 10-day growth periods. The nitrogen-free extract increased steadily with the advance in days' growth. A part of this increased percentage may have been due to the formation of nutrients in the seeds. The nitrogen-free extract is lower and the crude protein is somewhat higher for the last period than was to be expected for 71 to 82 days' growth. Five of the seven samples analyzed for this period were from second cuttings, and the analysis probably indicates that weather conditions so affected the growth that the second-cutting hay was less mature (according to head formation) with 71 to 82 days' growth than was the hay with a growth period of 61 to 70 days.

YIELDS OF DRY MATTER AND PROTEIN PER ACRE

In 1928 the yield of crude protein per acre was 367.6 pounds for the first-heads-out stage, 291 pounds for the full-head stage, and only 195 pounds per acre for the soft-dough-stage hay. (Table 4.) This is an increase of 172 pounds, or 88 per cent, in favor of the first-heads-out hay over the soft-dough-stage hay.

In 1929, because of the greater yields of dry matter and higher crude-protein content, the yields of crude protein per acre were materially greater than in 1928. First-heads-out hay ranked first again, with an increase of 45 per cent over the full-head hay, and 35 per cent over the soft-dough-stage hay. Owing to poor recovery after cutting and consequent low yields of air-dry hay, the yield of crude protein for the 30-day-stage hay was 344 pounds per acre. In 1930, however, the reverse was true.

The average yields of crude protein per acre for the various cuttings for the three years were as follows:

	Pounds per acre
First heads out	403. 6
Full head	317. 8
Milk or soft dough	284. 7
30-day stage (2 years)	363. 6

The average of the three years' yields for each stage shows an advantage of 85.8 and 118.9 pounds, respectively, of crude protein per acre of first-heads-out hay over the full-head and soft-dough stages. These represent increases of 27 and 42 per cent, respectively. One acre of Sudan-grass hay cut at the first-heads-out stage yielded as much crude protein as 1.27 acres of hay cut when fully headed and as much as 1.42 acres when cut in the milk or soft-dough stage.

The average yields of crude protein of the two years (1929 and 1930) in the hay cut approximately every 30 days was 363.6 pounds, second only to the first-heads-out hay.

FEEDING EXPERIMENTS WITH HAY

During the winters of 1928 and 1929 feeding trials were conducted with groups of registered Holstein-Friesian cows with the Sudan-grass hay which had been cut at the different stages of maturity the previous summer. All groups were made up of three milking cows each, and the groups were balanced as nearly as possible according to age, size, stage of lactation, etc. The respective hays were fed to each group ad libitum, and no attempt was made to force them to

eat the stemmy or unpalatable portion of the hay. That portion of the hay refused was carefully weighed daily, and samples of the refused portion were taken for analyses. All of the cows were accustomed to eating Sudan-grass hay.

A grain mixture, made up of 4 parts ground kafir, 4 parts wheat bran, 1 part linseed meal, and 1 part cottonseed meal was fed to each group at the rate of 1 pound of grain to 5 pounds of milk produced.

A good quality of kafir silage was fed at the rate of 1 pound of silage per 100 pounds of body weight. The silage was limited to insure a higher consumption of hay.

The feeding periods lasted for 28 days, preceded by a 7-day preliminary period to accustom the cows to the feed. During the preliminary period all groups of cows were fed the feeds at the rate given. While these periods are shorter than was desired, it was the best that could be done under prevailing circumstances.

During 1928 groups 1, 2, 3, and 4 were fed simultaneously. The first cutting only of the various stages of Sudan-grass hay was fed. During 1929, groups 1, 2, 3, and 5 were fed simultaneously, and the alfalfa-hay check group was fed later in the winter. Some hay from all cuttings of each stage of maturity was fed during 1929.

The alfalfa hay fed the check groups was locally grown creek-bottom hay that would grade as United States No. 1. The alfalfa hay fed during 1929 was thought to be of slightly better quality than that fed in 1928. However, the crude-protein content of the alfalfa hay fed in 1929 was only 15.3 per cent whereas that fed in 1928 was 17.6 per cent.

The groups were all fed and handled under similar conditions. All cows had been raised on the experimental farm and were of similar breeding. They were accustomed to eating all of the feeds used in this experiment. They were milked twice each day. All feed was fed in mangers in the barn. Conditions other than the kind and quality of the hay fed were maintained as comparable as possible with the number of available animals.

Table 6 gives the essential data concerning age, weight, and production of the cows by groups.

The groups were fairly well balanced according to age, stage of lactation, and average daily milk production, for the respective years. The average number of days in milk, however, was considerably greater for the 1928 groups than for the 1929 groups. The cows used in 1928 averaged 205 days in lactation, while those in 1929 averaged only 138 days in lactation. The average daily milk production at the beginning of the trials was almost 10 pounds less per day for the cows used in 1928 than for the cows used in 1929. The body weight averaged 24 pounds per cow greater for 1929 than for 1928 at the beginning.

TABLE 6.—*Average age, body weight, feed consumption, and milk production of groups of cows fed Sudan-grass hay cut at various stages of maturity, 1928 and 1929*

Stage of cuttings, group, and year	Average age of cows	Stage of lactation at start	Average daily milk yield at start [1]	Hay fed in 28 days	Hay consumed—		Hay refused in 28 days		Grain consumed in 28 days
					In 28 days	Per cow per day			
	Years	*Days*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Per cent*	*Pounds*
First heads out:									
Group 1, 1928	6	158	25.1	3,000	2,409	28.6	591	19.7	380.8
Group 1, 1929	6½	136	34.7	3,335	2,807	33.4	528	15.8	562.8
Full head:									
Group 2, 1928	5½	196	22.0	2,490	1,642	19.5	848	34.0	324.1
Group 2, 1929	4	150	33.9	3,300	2,626	31.4	674	20.4	503.0
Soft dough:									
Group 3, 1928	4½	232	25.3	2,490	1,737	20.6	753	30.2	360.5
Group 3, 1929	5	135	32.3	3,300	2,693	32.0	607	18.3	491.4
Cut every 30 days:									
Group 5, 1929	5½	131	33.6	3,265	2,726	32.4	539	16.5	547.4
Alfalfa check:									
Group 4, 1928	5	234	23.1	2,380	2,288	27.2	92	3.8	347.9
Group 4, 1929	5½	132	33.4	2,777	2,747	32.7	30	1.1	568.4

Stage of cuttings, group, and year	Silage consumed in 28 days	Milk produced—			Increase (+) or decrease (−) in milk yield		Average body weight per cow		
		In 28 days	In first 7 days	In last 7 days			At beginning	At end	Increase (+) or decrease (−)
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Per cent*	*Pounds*	*Pounds*	*Pounds*
First heads out:									
Group 1, 1928	1,172.5	1,861.9	496.2	449.2	−41.0	−8.4	1,398	1,410	+12
Group 1, 1929	1,131.9	2,806.5	701.9	701.4	−.5	−.1	1,347	1,333	−14
Full head:									
Group 2, 1928	1,064.0	1,536.0	409.6	385.1	−44.5	−10.9	1,271	1,296	+25
Group 2, 1929	1,028.3	2,431.8	617.7	600.3	−17.4	−2.8	1,229	1,214	−15
Soft dough:									
Group 3, 1928	1,028.3	1,706.0	438.6	431.4	−7.2	−1.6	1,221	1,243	+22
Group 3, 1929	1,072.4	2,304.4	598.1	591.5	−6.6	−1.1	1,304	1,277	−27
Cut every 30 days:									
Group 5, 1929	1,083.6	2,711.7	696.8	664.3	−32.5	−4.7	1,290	1,291	+1
Alfalfa check:									
Group 4, 1928	1,050.0	1,726.1	444.2	436.7	−7.5	−1.7	1,239	1,303	+64
Group 4, 1929	1,142.5	2,889.3	709.8	729.5	+25.7	+3.6	1,370	1,385	+15

[1] Average of 7-day preliminary period.

PALATABILITY AND CONSUMPTION OF THE HAYS CUT AT DIFFERENT STAGES OF GROWTH

An analysis of Table 6 shows clearly that the Sudan-grass hay cut at the first-heads-out stage was more palatable and more of it was consumed with less refused than of hay cut at later stages. Only 591 pounds of the first-heads-out hay was refused, in spite of the fact that this group of cows was offered 3,000 pounds of this hay as compared to the 2,490 pounds of full-head and soft-dough hay that was offered to groups 2 and 3, respectively. However, the cows in group 1 were considerably heavier in body weight than those in the other groups and were a little older. In 1929, however, when the amount of hay fed was approximately the same for groups 1, 2, and 3, only 15.8 per cent of the first-heads-out hay was refused as compared with 20.4 per cent of the full-head hay and 18.3 per cent of the soft-dough-stage hay. This difference in the amounts of hay refused in the two years is probably due to the fact that the later cuttings of the hay fed in 1929 were more immature than the first cuttings only

that were fed in 1928. During the 1929 feeding trial, more of the first-heads-out hay was consumed than of the 30-day hay and less was refused. This was rather unexpected, and brings out the fact that there was probably little difference in the palatability of these two hays. The two cuttings of first-heads-out hay fed in 1929 represented approximately 45 days' growth. In other words, the 12 to 15 days' difference in growth between the first-heads-out and 30-day hay under the climatic conditions that prevailed in 1929 had but little effect on the palatability of the two stages of hay.

Another interesting point in both years' results is the fact that more of the first-heads-out hay was consumed per cow per day than of any of the other hay fed, including alfalfa. The hay consumption was heavier in all groups in 1929, probably because the hay was of better quality and the cows were producing more milk than in 1928. Another reason is that the cows in 1929 were fed some second-cutting hay, which in the full-head and soft-dough stages was higher in protein and lower in crude fiber than that from the first cutting. Only first-cutting hay of the three respective stages was fed in 1928, and this hay was rather coarse and stemmy, owing to heavy rainfall in May and June. There was but little difference in the hay consumption per cow per day for all of the groups in 1929.

Table 7 shows these consumption figures applied to the yields of hay for both years.

TABLE 7.—*Yields of edible Sudan-grass hay per acre when cut at different stages of maturity, 1928 and 1929*

Stage of cutting and year	Yield per acre [1]	Amount refused by cows	Yield of edible hay per acre
First heads out:	*Pounds*	*Per cent*	*Pounds*
1928	3,723	19.7	2,990
1929	5,172	15.8	4,355
Full head:			
1928	3,911	34.0	2,581
1929	4,840	20.4	3,853
Soft dough:			
1928	3,554	30.2	2,481
1929	5,131	18.3	4,192
Cut every 30 days:			
1929	3,043	16.5	2,541

[1] Air-dry basis.

MILK YIELDS DURING THE EXPERIMENTS

The decline in milk production over the 28-day periods (the first 7 days compared with the last 7 days) was considerably greater in all groups in 1928 than in 1929. (Table 6.) This was due partly to the fact that in 1928 the cows averaged 68 days longer in lactation at the beginning of the trial than did the cows in 1929.

It is rather difficult to interpret the greater decline in milk of group 1, fed first-heads-out hay in 1928 as compared with group 3, fed the soft-dough-stage hay. Group 1 consumed more hay, and the hay was of better quality, as shown by the analyses, than was that fed to group 3. Then too, group 1 consumed approximately 20 pounds more grain and 144 pounds more kafir silage than did group 3. However, the grain consumed according to milk produced was at a slightly higher ratio for group 1 than for group 3. Group 1 had averaged 158 days in lactation when the trial started, while group 3 had averaged 232 days. A study of the records of consumption and

production of the individual animals does not offer sufficient reason for the greater decline. A comparison of the nutrients consumed with the amounts required, as shown in Table 8, indicates that all groups for both years were fed in excess of their requirements. In 1928 the cows in group 1 consumed approximately 20 per cent of total digestible nutrients in excess of their requirements, while groups 2 and 3 consumed only 1.4 per cent and 6.2 per cent, respectively, in excess of their requirements. Perhaps the real reason for the lower rate of decline from the first period to the fourth period of the trial is that group 3 on soft-dough hay suffered such a great decline between the preliminary 7-day period and the first 7-day period of the feeding trial. The comparative percentage declines computed in one case from the production in the first 7-day period to the last 7-day period of the feeding trial, and in the other case from the production during the 7-day preliminary period to that of the last 7-day period of the trial (Table 9), shows that in both 1928 and 1929 the cows on soft-dough hay were second only to the cows fed the full-head hay in the greatest percentage decline when measured from the production during the preliminary 7-day period.

TABLE 8.—*Nutrients (pounds) consumed in feed and required for maintenance and production by groups of cows fed Sudan-grass hay cut at various stages of maturity, during 28-day feeding period, 1928 and 1929*

Stage of cutting and year	Feed consumed during 28 days			Digestible nutrients consumed in—				Average body weight
	Hay	Grain	Silage	Hay	Grain	Silage	Total	
First heads out:								
1928	2,400	380.8	1,172	1,354	273	205	1,832	1,404
1929	2,807	562.8	1,131	1,508	403	198	2,109	1,340
Full head:								
1928	1,642	324.1	1,064	945	232	186	1,363	1,283
1929	2,626	503.0	1,028	1,423	360	180	1,963	1,221
Soft dough:								
1928	1,737	360.5	1,028	1,010	258	180	1,448	1,232
1929	2,603	491.4	1,072	1,351	352	188	1,891	1,290
Cut every 30 days:								
1929	2,726	574.4	1,083	1,361	392	189	1,942	1,290
Alfalfa check:								
1928	2,288	347.9	1,050	1,288	249	183	1,720	1,271
1929	2,747	568.4	1,142	1,542	407	200	2,149	1,377

Stage of cutting and year	Total milk production	Digestible nutrients required			Excess of digestible nutrients consumed above requirements		Digestible nutrients consumed obtained from hay (per cent)
		For maintenance [1]	For production	Total	During period	Per cow per day	
First heads out:							
1928	1,862	955	594	1,529	303	3.6	74
1929	2,806	891	895	1,786	323	3.8	71
Full head:							
1928	1,536	855	489	1,344	19	.2	69
1929	2,431	811	775	1,586	377	4.5	73
Soft dough:							
1928	1,706	819	544	1,363	85	1.0	69
1929	2,394	858	763	1,621	270	3.2	71
Cut every 30 days:							
1929	2,712	858	865	1,723	219	2.6	70
Alfalfa check:							
1928	1,726	846	552	1,398	322	3.8	75
1929	2,889	918	921	1,839	310	3.7	72

[1] Savage feeding standard.

It is probable, too, that the limited number of cows in each group and the short duration of the feeding trials (28 days) did not allow sufficient time to bring about the greater difference in the comparative feeding value of these hays that was to be expected from the difference in composition.

FEED CONSUMED AND MILK PRODUCED, BY 7-DAY PERIODS

The amounts of the various feeds consumed and the amount of milk produced by the various groups, by 7-day periods, are shown in Table 9. The feed records for the week previous to the preliminary 7-day periods are also shown.

TABLE 9.—*Feed consumption and milk production (pounds) by 7-day periods by groups of cows fed Sudan-grass hays cut at different stages of maturity, and alfalfa hay, 1928 and 1929*

Stage of cutting, group, and year	Feed consumed			Milk produced
	Grain	Hay	Silage	
WEEK BEFORE PRELIMINARY PERIOD				
First heads out:				
Group 1, 1928	141.0	287	804	-------
Group 1, 1929	128.8	276	812	-------
Full head:				
Group 2, 1928	149.0	270	782	-------
Group 2, 1929	149.0	252	756	-------
Soft dough:				
Group 3, 1928	154.0	261	777	-------
Group 3, 1929	141.4	259	791	-------
Cut every 30 days:				
Group 5, 1929	146.4	266	798	-------
Alfalfa (check):				
Group 4, 1928	136.0	[1] 262	726	-------
Group 4, 1929	140.3	[2] 277	291	721.0
PRELIMINARY 7-DAY PERIOD				
First heads out:				
Group 1, 1928	147.0	288	829	528.7
Group 1, 1929	138.0	266	812	728.3
Full head:				
Group 2, 1928	151.0	270	812	462.1
Group 2, 1929	149.0	252	756	711.6
Soft dough:				
Group 3, 1928	154.0	261	777	531.3
Group 3, 1929	141.4	259	791	678.8
Cut every 30 days:				
Group 5, 1929	148.4	266	795	709.6
Alfalfa (check):				
Group 4, 1928	140.0	[1] 263	784	485.8
Group 4, 1929	135.5	288	861	701.0
FIRST 7-DAY PERIOD				
First heads out:				
Group 1, 1928	105.0	547	203	490.2
Group 1, 1929	144.2	693	283	701.9
Full head:				
Group 2, 1928	92.4	371	260	409.6
Group 2, 1929	141.4	613	258	617.7
Soft dough:				
Group 3, 1928	109.0	398	256	438.6
Group 3, 1929	134.4	650	272	598.1
Cut every 30 days:				
Group 5, 1929	140.7	698	271	696.8
Alfalfa (check):				
Group 4, 1928	93.1	527	260	444.2
Group 4, 1929	139.3	667	288	703.8
SECOND 7-DAY PERIOD				
First heads out:				
Group 1, 1928	97.3	624	291	467.9
Group 1, 1929	139.3	713	283	702.8
Full head:				
Group 2, 1928	81.2	436	282	385.8
Group 2, 1929	121.5	654	257	605.0
Soft dough:				
Group 3, 1928	86.8	432	251	416.8
Group 3, 1929	118.3	678	267	600.1
Cut every 30 days:				
Group 5, 1929	138.6	693	274	706.5
Alfalfa (check):				
Group 4, 1928	88.2	604	260	419.8
Group 4, 1929	140.0	700	278	727.3
THIRD 7-DAY PERIOD				
First heads out:				
Group 1, 1928	92.4	606	291	454.6
Group 1, 1929	140.0	705	283	700.4
Full head:				
Group 2, 1928	77.0	389	266	375.5
Group 2, 1929	119.7	603	256	603.8
Soft dough:				
Group 3, 1928	81.9	434	258	419.2
Group 3, 1929	119.0	664	265	604.7
Cut every 30 days:				
Group 5, 1929	140.0	627	271	644.1
Alfalfa (check):				
Group 4, 1928	83.8	605	262	425.4
Group 4, 1929	144.2	690	280	728.7
FOURTH 7-DAY PERIOD				
First heads out:				
Group 1, 1928	86.1	631	298	449.2
Group 1, 1929	139.3	696	284	701.4
Full head:				
Group 2, 1928	73.5	446	270	365.1
Group 2, 1929	120.4	691	258	600.3
Soft dough:				
Group 3, 1928	83.3	473	263	431.4
Group 3, 1929	119.7	701	267	591.5
Cut every 30 days:				
Group 5, 1929	128.1	708	268.1	694.3
Alfalfa (check):				
Group 4, 1928	83.3	605	268	436.7
Group 4, 1929	144.9	690	291	729.5

[1] This group was fed Sudan-grass hay during this 7-day period.
[2] Sudan-grass hay fed during this period.

In 1928 there was a gradual increase in hay consumption for all groups from the first to the last 7-day period of the 28-day trial. Groups 1 and 2 for some unknown reason fell off rather heavily in hay consumption during the third period, while groups 3 and 4 maintained their consumption. During the fourth and last 7-day period groups 1, 2, and 3 increased materially the amount of hay consumed, while that consumed by group 4 remained the same. Groups 1 and 2 declined steadily in milk production from the first to the last period. All four groups showed a decided drop in production during the second period, but groups 3 and 4 increased their production for the last two periods. The cows in all groups were fed grain at a higher rate during the preliminary 7-day period than they were during the feeding trial. The rate of grain to milk produced was 1 to 3.4 during the preliminary period, while the rate was decreased to 1 pound of grain to 4.5 pounds of milk produced for the first period. The amount of silage fed was also decreased from an average of 26.7 pounds per cow per day to approximately 10 pounds per cow a day. The amount of hay consumed increased materially between the two periods. Such an abrupt change in the ration resulted in lowered production. This was probably the reason for the heavy decrease by all groups during the first 7-day period.

For 1929 the rate of grain feeding for the preliminary period was approximately the same as for the first regular 7-day period, namely, 1 to 4.7. There was an abrupt change in the rate of hay and silage feeding. All of the groups except group 2 on full-head hay produced more milk in the second 7-day period than in the first 7-day period. The cows in 1929 consumed much greater amounts of hay than the cows in 1928. The groups on first-heads-out and alfalfa hay consumed 16.6 and 17.3 per cent more hay respectively during the feeding periods in 1929 than in 1928. The large increases in consumption, however, were in the full-head and soft-dough hay groups, which were 60 and 55 per cent greater in 1929 than in 1928. These great increases were due in part to the fact that the cows in 1929 were fed some hay from all cuttings, whereas in 1928 hay from the first cuttings only was fed. The full-head and the soft-dough hay from the second cuttings in 1929 were higher in protein and lower in crude fiber than the hay from the first cuttings. This probably accounts for the lower decline in milk yields in 1929. Then, too, the cows fed the full-head and soft-dough-stage hay in 1929 consumed a greater margin of total digestible nutrients over requirements than did the cows in 1928.

FEEDING SUDAN-GRASS SILAGE IN COMPARISON WITH SUDAN-GRASS HAY FOR MILK PRODUCTION

FEEDING EXPERIMENTS WITH SILAGE, AND WITH HAY AND SILAGE, MADE AT FULL-HEAD STAGE

Comparative feeding data were secured for one year (1929) on two groups of cows of which one group was fed Sudan-grass silage made at the full-head stage and the other group was fed Sudan-grass hay and Sudan-grass silage made at the full-head stage. These two groups of three cows each were fed for a period of 42 days under the same conditions as were those which were fed the Sudan-grass hay at the three stages of maturity. A grain ration of the same composition as that used in the previous experiments was fed at the rate of 1 pound of grain to 5 pounds of milk produced daily.

The hay was cut at the full-head stage in 1929 and represented a portion of the hay discussed in the previous experiment. The silage was cut at the same stage and at the same time as the full-head hay and was immediately placed in a pit silo. Some wilting took place before ensiling. The silage was of excellent quality and was very palatable.

In the case of the silage-fed group, care was taken to feed the cows only the amount they would readily clean up. For the group fed hay and silage, an attempt was made to feed both ad libitum, but it is possible that in doing this the hay may have been limited to a small extent. However, the percentage of hay refused by this group (23.4 per cent) is not greatly out of line with the percentage of fully headed hay refused (20.4 per cent) by the cows in the previous 28-day hay feeding trial.

Table 10 is a summary of this feeding trial.

TABLE 10.—*Consumption and feeding value of full-head Sudan-grass silage compared with Sudan-grass hay and Sudan-grass silage over 42-day feeding period, 1929*

Material fed	Average age of cows	Stage of lactation at start	Average body weight per cow at start	Average loss in body weight for 42 days	Average daily milk yield at start	Milk produced		Decline in milk yield
						During 42 days	Per cow per day	
	Years	*Days*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Per cent*
Silage	5½	132	1,227	36	34.6	3,921.4	31.1	14.7
Hay and silage	5½	129	1,260	32	36.6	3,969.3	31.5	17.2

Material fed	Roughage consumed				Roughage refused		Dry matter consumed per cow per day in roughage[1]	Grain consumed during 42 days
	Silage		Hay		Silage	Hay		
	In 42 days	Per cow per day	In 42 days	Per cow per day				
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Per cent*	*Per cent*	*Pounds*	*Pounds*
Silage	11,316	89.8			0		29.6	805.0
Hay and silage	9,649	76.5	1,313	10.4	.1	23.4	34.6	821.4

[1] Silage and hay averaged 33 and 90 per cent dry matter, respectively.

These two groups of cows were evenly balanced in age, stage of lactation, and milk production at the start. The daily consumption of dry matter per cow was approximately 5 pounds greater for the hay plus silage group.

Table 11 shows the average daily consumption and milk production per cow for the six 7-day periods. The group fed silage alone started with a heavy consumption but apparently lost their appetite for such a large quantity before the third 7-day period. Their consumption gradually diminished until the end of the period. There were apparently no bad effects on the health of this group of cows, as they appeared normal in every way.

TABLE 11.—*Average daily roughage consumption and average daily milk production per cow by 7-day periods when fed full-head Sudan-grass silage, and Sudan-grass hay and silage, 1929*

7-day period	Cows fed silage		Cows fed hay and silage		
	Silage consumed	Milk produced	Hay consumed	Silage consumed	Milk produced
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Preliminary		34.6			36.6
First	104.1	33.3	11.5	68.5	34.6
Second	104.2	33.1	10.2	78.0	33.7
Third	88.8	32.2	10.1	81.1	32.2
Fourth	91.6	30.5	10.1	85.2	30.6
Fifth	77.7	29.3	10.0	76.8	29.1
Sixth	73.0	28.4	10.5	69.7	28.7
Average	89.8	31.1	10.4	76.5	31.5

As the experiment with Sudan-grass hay cut at different stages in 1929 included a group of cows fed full-head hay and kafir silage at the rate of 1 pound per 100 pounds of live weight, their feed consumption and milk yield is comparable with the group fed silage made from full-head Sudan grass as the only roughage and the group fed hay and silage made from full-head Sudan grass. The average consumption of dry matter in the roughage and percentage decline in milk yield of these groups is given in Table 12.

TABLE 12.—*Average dry-matter consumption and average decline in milk yield by 7-day periods for cows on full-head Sudan-grass hay and kafir silage, full-head Sudan-grass silage, and full-head Sudan-grass hay and Sudan-grass silage, 1929*

7-day period	Cows on Sudan-grass hay and kafir silage		Cows fed Sudan-grass silage		Cows fed Sudan-grass hay and Sudan-grass silage	
	Dry matter in roughage	Milk decline	Dry matter in roughage	Milk decline	Dry matter in roughage	Milk decline
	Pounds	*Per cent*	*Pounds*	*Per cent*	*Pounds*	*Per cent*
First	212	13.2	240	3.7	230	5.4
Second	224	2.1	240	0.6	244	2.6
Third	228	[1] 0.6	205	3.0	251	4.4
Fourth	235	1.4	211	5.2	260	5.0
Fifth			179	3.9	240	4.9
Sixth			169	3.0	227	1.3

[1] Increase.

The feeding trial for the group on Sudan-grass hay and kafir silage lasted only 28 days, while for the groups on Sudan-grass silage, and Sudan-grass hay and silage the feeding trials lasted 42 days. The consumption of dry matter in the form of roughage, of the group on hay and kafir silage, increased steadily with each 7-day period, while the percentage decline in milk yield was much lower than for the other two groups except in the first and second 7-day periods following the preliminary period.

The consumption of dry matter in the roughage part of the ration for the group on Sudan-grass hay and Sudan-grass silage also increased

steadily up to the last two periods, when there was a decrease. The decline in milk yield was steady for each 7-day period, except for the second and sixth periods. The cows in this group consumed 73 per cent of the total dry matter in the roughage ration, in the form of Sudan-grass silage, while the cows receiving Sudan-grass hay and kafir silage consumed only 13 per cent of the dry matter in the roughage part of the ration in the form of silage.

The consumption of dry matter in the group on Sudan-grass silage alone was less than that for the other two groups except for the first and second 7-day periods. There was a decrease in consumption of dry matter throughout the experiment. The decline in milk flow was rather uniform except for the second period.

Comparing the declines in milk yield for the three groups for the duration of the experiment, that is, from the yield for the 7-day preliminary period to the yield for the last 7-day period of the feeding trial, it is seen that the decline for the group on hay and kafir silage is 16 per cent; that for the group on Sudan-grass silage alone the decline is 11.8 per cent to the end of the fourth period (when the trial on hay and kafir silage ended) and 17.9 per cent to the end of the sixth period; and that for the group on Sudan-grass hay and Sudan-grass silage the decline is 16.4 per cent to the end of the fourth 7-day period and 21.6 per cent to the end of the sixth period. The decline for the cows on silage seems to be at a lower rate, in spite of the fact that their consumption of dry matter was less than that of the other groups. This is in agreement with the results of an experiment conducted by this bureau [5] comparing the value for milk production of hay and silage made from pasture herbage. The decline for the group fed hay and kafir silage and that for the group fed hay and Sudan-grass silage is approximately the same. From these results it appears that, pound for pound of dry matter, the silage was somewhat more efficient in stimulating milk flow than was field-cured hay made from Sudan grass of the same stage of maturity.

FEEDING EXPERIMENTS WITH SILAGE AND WITH HAY, MADE AT THE FIRST-HEADS-OUT STAGE

Since the experiments comparing the value of hay made from Sudan grass cut at three different stages of maturity showed that the hay cut when first heads appeared was more efficient in maintaining milk yield than was the hay cut at later stages of maturity, an experiment was conducted in 1931 to determine the relative efficiency in maintaining milk production, of hay and silage made from Sudan grass cut when the first heads were appearing.

The silage was made from the first of three cuttings. Some water was added to the grass as it went into the silo. The silage made from Sudan grass in 1929 kept well, and there was little spoilage, but unfortunately the 1931 silage did not keep well. It was warm to the touch of the hand throughout the 42-day feeding trial and spoiled rapidly when exposed to the air. It was necessary to separate the moldy silage from the good, by hand, as it was removed from the silo.

Two groups of three cows each were used in the experiment. Both groups were fed a grain mixture at the rate of 1 pound to each 5 pounds of milk produced. The grain mixture consisted of 4 parts ground wheat, 4 parts wheat bran, 1 part cottonseed meal, and 1 part

[5] Unpublished data.

linseed meal. The cows in one group received hay made from Sudan grass cut at the first-heads-out stage, ad libitum. No other hay or silage was fed. The cows in the other group received silage made from Sudan grass cut at the same stage of maturity, ad libitum. No other silage or hay was fed. The cows in the hay-fed group averaged 143 days in lactation and 1,355 pounds in body weight, and the cows in the silage-fed group averaged 139 days in lactation and 1,368 pounds in body weight.

The total feed consumption, milk yield, and decline in milk yield by 7-day periods is shown in Table 13.

TABLE 13.—*Consumption of hay and silage made from Sudan grass cut at the first-heads-out stage and the milk yield by 7-day periods, 1931*

HAY GROUP

7-day period	Total feed consumed			Total milk yield	Decline (−) or gain (+) in milk production over preceding period	
	Hay	Silage	Grain			
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Per cent*
Preliminary	(1)	[2] 868	225.4	849.7		
First	808	None.	169.4	840.8	−8.9	−1.04
Second	707	None.	167.3	851.6	+10.8	+1.28
Third	693	None.	168.7	844.9	−6.7	−.78
Fourth	722	None.	168.7	819.5	−25.4	−3.00
Fifth	715	None.	162.4	803.6	−15.9	−1.94
Sixth	702	None.	159.6	785.2	−18.4	−2.28

SILAGE GROUP

Preliminary	(1)	[2] 882	224.0	826.3		
First	None.	1,675	167.3	754.6	−71.7	−8.67
Second	None.	1,665	150.5	824.1	+69.5	+9.21
Third	None.	1,410	163.1	827.8	+3.7	+.44
Fourth	None.	1,540	164.5	814.9	−12.9	−1.55
Fifth	None.	1,675	161.7	790.4	−24.5	−3.00
Sixth	None.	1,564	157.5	772.6	−17.8	−2.25

[1] Hay was fed ad libitum, but not weighed.
[2] Kafir silage.

The cows in the hay group were fed the hay at an average rate of 44.7 pounds per cow per day and consumed 34.5 pounds per day, the refusal averaging 10.2 pounds or 22.8 per cent. The cows on silage consumed the silage at an average rate of 75.6 pounds per cow per day, which is considerably less than the average consumption of 89.8 pounds of Sudan-grass silage in 1929. This difference is no doubt due to spoilage of the 1931 silage. The hay consumption is a little greater than for the same kind of hay in 1929. The consumption of hay, and also of silage, would have been greater had no grain been fed.

The consumption of hay by 7-day periods by the cows in the hay group was greatest in the first period, averaging 38.5 pounds per cow per day. The average consumption dropped to 33.6 pounds per day in the second period, and during the remainder of the experiment varied less than a pound from that figure during any 7-day period.

The consumption of silage by 7-day periods by the cows in group 2, was approximately the same in the first and second periods, averaging 79.8 and 79.3 pounds per cow per day. In the third period the average consumption dropped to 67.1 pounds, probably on account of a difference in the quality of the silage fed. In the fourth period the con-

sumption increased to 73.3 pounds, and in the fifth period to 79.8 pounds, but in the sixth period dropped back to an average of 74.5 pounds per cow per day. There was not the steady decline in consumption of silage in this experiment that was experienced with the silage made from Sudan grass when fully headed, in 1929. The percentages of dry matter in the hay and silage fed in this experiment had not been determined when this was written. If the percentages of dry matter that were found in the 1929 hay and silage are applied to the quantities of hay and silage consumed in 1931, the cows on the silage ration consumed 24.1 per cent less dry matter than the hay-fed cows in the first 7-day period and 18.4 per cent less dry matter in the last 7-day period. Since the quantity of grain fed both groups is practically the same, this figure represents the difference in dry-matter consumption in the entire ration, provided the error in using the 1929 percentages of dry matter is not too great. The difference in dry-matter consumption in the last 7-day period in the 1929 experiment between the silage-fed group and the group fed both hay and silage was 25.5 per cent in favor of the hay and silage fed group.

With this greater dry-matter consumption of the cows receiving hay, it might be expected that these cows would decline in milk flow at a slower rate than the silage-fed cows. Such was not the case, however. A comparison of the milk yield in the preliminary 7-day period with the yield in the last 7-day period shows a decline of 7.59 per cent for the hay-fed cows and 6.49 per cent for the silage-fed cows. The milk decline of the cows fed full-head Sudan-grass silage in the 1929 experiment was 18 per cent, and the decline for the cows in that experiment that were fed both hay and silage was 21 per cent. It appears, therefore, that the silage made from Sudan grass cut at the first-heads-out stage was more efficient for milk production than the silage made from grass cut when fully headed, even though the former was not of the best quality. Also, as in the 1929 experiment, and as in an experiment with hay and silage made from pasture herbage at the Huntley, Mont., station,[7] the dry matter of the Sudan-grass silage was, pound for pound, more valuable for milk production than was that in the field-cured hay cut from grass at the same stage of maturity.

The decline in milk yield of the cows fed Sudan-grass hay cut at the first-heads-out stage in 1931, from the preliminary 7-day period to the fourth 7-day period of the experiment, which compares with the length of the feeding trials in 1929, was 3.5 per cent. The decline for the cows fed Sudan-grass hay cut at this same stage of maturity in 1929 but with kafir silage in addition, was 3.7 per cent. This suggests that the addition of the kafir silage to the ration, fed at the rate of 1 pound of silage to each 100 pounds of live weight, was of no particular value. The decline for the cows fed fully headed hay with kafir silage, in 1929, for this same period of time, was 15.6 per cent. This emphasizes again, the superior value for milk production of Sudan-grass hay cut at an immature stage of development.

In view of the fact that both groups of cows in 1931 were fed during the preliminary seven days a ration of Sudan-grass hay ad libitum, and kafir silage at the rate of 41 and 42 pounds per day per cow, respectively, and a grain mixture at the rate of 1 pound to each 3.7

[7] Unpublished data.

pounds of milk produced, and that during the experimental periods they were fed hay alone or silage alone, and the grain mixture at the rate of 1 pound to each 5 pounds of milk produced, the return to the same level of production during the second and third 7-day periods as that of the preliminary period is rather remarkable. With no knowledge of any environmental factors that might have caused a depression of the milk yield during this preliminary period, this return to the same level of production in the second and third weeks thereafter, accompanied by a decreased grain consumption, suggests that the dry matter consumed in the hay and the silage during the experimental feeding period was much superior for milk production to that fed in the hay and silage during the preliminary period. It is again suggested that where the dry matter in the hay and in the silage is of equivalent value for milk production there is probably no advantage in feeding hay with silage or silage with hay. This is borne out to a certain extent by the results of an experiment conducted at the Beltsville (Md.) Experiment Station comparing the value of beet pulp when soaked with water and when fed in the dry state.[8] The dry pulp proved to be as palatable as the wet, and the production of milk was as great in one case as in the other.

The cows were weighed on the last two days of each 7-day period. The net gains or losses in weight are calculated by comparing the average weight of the group for the last two days of the 7-day preliminary period, with the average weight for the last two days of the sixth 7-day period. The 3 cows in the hay group had a net loss of 28 pounds, 1 cow lost 35 pounds, 1 cow lost 55 pounds, and the third cow gained 62 pounds. The 3 cows in the silage group had a net loss of 44 pounds, 1 cow lost 33 pounds, 1 lost 18 pounds, and the third cow gained 7 pounds.

The difference in loss between the two groups is too small to be significant.

VALUE OF SUDAN-GRASS PASTURE FOR MILK PRODUCTION

An experiment was started in 1928 to determine the value of Sudan-grass pasture for carrying capacity and milk production. Results of four seasons' work (1928 to 1931, inclusive) are here reported.

Two and one-half acres were seeded each year at the rate of 12 pounds per acre. As soon as the grass had made sufficient growth, grazing with milking cows was started. Care was taken to select only cows that were normal in lactation. Cows were added to the plots or taken off according to the growth of the grass. At times, because of favorable conditions, as many as six cows were on the plots, while at times of poor growth conditions, no cows were grazed for considerable periods of time. Accurate records were kept of the days that cows were grazed, their milk and butterfat production during the days they were on pasture, their body weight, and the grain or other feed they consumed while on pasture.

The cows were of similar breeding, and conditions other than pasture were kept as nearly comparable as possible. They were milked twice daily except in 1931.

Table 14 shows the essential data for the four years 1928 to 1931.

[8] WOODWARD, T. E., SHEPHERD, J. B., and GRAVES, R. R. FEEDING AND MANAGEMENT INVESTIGATIONS AT THE UNITED STATES DAIRY EXPERIMENT STATION AT BELTSVILLE, MD., 1930 REPORT. U. S. Dept. Agr. Misc. Pub. 130: 12-14. 1932.

TABLE 14.—*Carrying capacity and milk and butterfat production of Sudan-grass pasture, 1928–1931*

Year	Date of seeding	Pasture season			Cows grazed on plots	Total cow-days[1] per acre	Supplemental feed per acre		Production per acre		Net gain in body weight per acre
		Opened	Closed	Length			Grain	Silage	Milk	Butterfat	
				Days	*Days*	*No.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1928	June 1	July 2	Oct. 17	108	76	94.8	689.4	870.4	3,717	105.4	56.8
1929	June 7	July 8	do	102	102	94.8	685.5	None.	4,519	134.1	55.2
1930	May 27	July 1	Sept. 30	92	44	52.8	371.8	None.	2,187	65.1	79.2
1931	June 8	July 9	Oct. 15	99	49	57.6	704.3	None.	2,378	72.7	−1.2
Average				100	68	75.0	601.0	218.0	3,200	94.3	47.5

[1] A cow-day is a 24 hour period, day and night, that one cow grazed.

In 1928 the pasture season lasted for 108 days, but cows were grazed on the plot for only 76 days. Because of long-continued dry weather no cows were grazed on the plot from August 18 to September 18, inclusive. The rainfall for the five months, May to September, inclusive (Table 3), totaled 13.01 inches, of which 11.85 inches fell in May, June, and July. Only 0.35 inch of rain fell in August and 0.81 inch in September.

The pasture season of 1929 began approximately one week later than that of 1928. There were 2.09 inches of rain in August and 4.45 inches in September. This distribution of rainfall resulted in sufficient growth of the Sudan grass to make it possible for a limited number of cows to be grazed throughout the season. The increase in production over that in 1928 was probably due to better grazing caused by the more favorable distribution of rainfall during the pasture season. However, this 2½-acre plot had been seeded to winter rye in the fall of 1927 and grazed during April and May, 1928. It then lay idle during the summer of 1928. This may have been partly responsible for the more favorable production.

In 1930 the grazing season extended over a period of only 92 days, but cows actually grazed only 44 days of this time. From July 25 to September 10 no grazing was available. A study of the rainfall in 1930 (Table 3), gives the reason for the short grazing season. Heavy rains fell in May and early June before the grass was well started. No effective rains came after June 9 until August, when 1.42 inches fell.

In 1931 the Sudan grass was seeded May 29. Heavy rainfall on June 5 (1.9 inches) washed and packed the surface of the soil so that practically none of the seed came through. The plot was reseeded June 8, and a good stand was secured. Grazing started July 9 with four cows, and they were kept on the plot continuously until August 1. Rainfall totaling 0.93 inch during August 1, 2, and 3 had no appreciable effect on the growth of the grass, and it did not recover sufficiently for grazing until September 4. On account of a shortage of suitable animals the cows used to graze the Sudan grass in 1931 were 2-year-old heifers on official test, and they were milked three times per day. In the previous experiments the cows had been milked twice a day. Although grain was fed at a heavier rate in 1931, the rate of milk yield was lower than in 1928 or 1929, and was very little greater than in 1930. The poor grazing season again illustrates the effect of poor distribu-

tion of rainfall during the pasture season on growth and recovery of Sudan grass after grazing.

The average of the four years' results shows that under conditions prevailing in this locality, approximately 75 cow-days of grazing per acre were obtained. An average production of 3,200 pounds of milk per acre, which contained 94 pounds of butterfat was secured for the four years, when the pasture was supplemented with a grain mixture fed at the average rate of 1 pound to each 5.3 pounds of milk produced.

VALUE OF SUDAN-GRASS PASTURE IN COMPARISON WITH SUDAN-GRASS HAY

In order to obtain a measure of the value of the nutrients in the Sudan-grass pasture the following method, devised by the Bureau of Dairy Industry,[8] was applied:

The total digestible nutrients necessary to maintain the cows at the average body weight for the periods that they grazed and for the milk they produced during those periods were calculated according to the Savage feeding standard. From the required nutrients thus calculated were deducted the nutrients contained in the grain and silage fed while the cows were on the Sudan-grass pasture. The difference was taken as the quantity of nutrients that could be credited to the pasture. By converting this quantity of nutrients into its equivalent of Sudan-grass hay or alfalfa hay, the value of the pasture was figured on a comparative basis with these hay crops. In making these calculations the average daily body weight of the cows by months or for the shorter periods they might have grazed was used. For example, a cow weighed 1,200 pounds on July 1, when she started to graze. She grazed continuously for 23 days, after which she was taken off. Her body weight when she was taken off was 1,220 pounds. Her average daily body weight for the 23 days was considered as 1,210 pounds, the average of the initial and final weights.

It is realized that several chances for error are present in these calculations, aside from the feeding-standard requirements and average analyses used in several cases: (1) The average daily body weight of the animals for the periods of grazing was used, and no attempt was made to calculate specific individual increases or losses in weight other than the average. All cows on Sudan-grass pasture showed a tendency to increase in body weight, except in 1931. This was also true in the hay-feeding experiment in 1928. In 1929, however, the group of cows fed first-heads-out Sudan-grass hay showed a tendency to lose weight. (2) That portion of the hay fed that was not consumed in the feeding trials of 1928 and 1929 is assumed to have contained the same percentage of nutrients as the hay that was consumed. In reality it consisted largely of stems and probably contained less nutrients. The nutrients obtained in the consumed portion of the hay for this reason were probably somewhat higher than the calculations indicate. (3) No effort was made to obtain the yield of aftermath after the grazing ended in the fall. A considerable quantity of heavy stems was left standing on the plots. Probably this would compensate somewhat for the portion of the hay that was refused by cows in the feeding trials. (4) Perhaps the greatest possibility of error in these calculations is that average coefficients of digestibility for Sudan-grass hay as given in Henry and Morrison's

[8] MOSELEY, T. W., STUART, D., and GRAVES, R. R. DAIRY WORK AT THE HUNTLEY FIELD STATION, HUNTLEY, MONT., 1918-1927. U. S. Dept. Agr. Tech. Bul. 116: 3. 1929.

Feeds and Feeding were used, since it was not possible to conduct digestion trials on the hay cut at different stages of maturity. It is probable that these coefficients of digestibility were obtained from hay made from Sudan grass cut at a more mature stage of development. There is reason to believe that the nutrients in such hay would not be as digestible as the nutrients from hay cut at an immature stage.

The results of these calculations for the four years covered by the grazing work are shown in Table 15.

TABLE 15.—*Calculated yield of total digestible nutrients (pounds) grazed from 1 acre of Sudan-grass pasture and its equivalent value in Sudan-grass hay and in alfalfa hay, 1928–1931*

Year and month	Cow-days of grazing	Digestible nutrients required for—		Total digestible nutrients required	Digestible nutrients in grain consumed	Calculated digestible nutrients credited to pasture	Hay required to furnish total digestible nutrients equivalent to pasture	
		Maintenance	Production				Sudan [1]	Alfalfa
1928								
July	46.4	437.780	518.312	956.092	178.542	777.550		
August	20.8	192.628	217.816	410.444	122.910	287.534		
September	7.2	68.532	81.708	150.240	[2] 85.708	64.532		
October	20.4	193.038	220.094	413.132	[2] 274.656	138.476		
Total	94.8	891.978	1,037.930	1,929.908	661.816	1,268.092	2,256	2,247
1929								
July	39.6	377.118	571.213	948.331	219.010	729.321		
August	29.6	305.830	413.842	719.672	190.958	528.714		
September	12.0	118.212	150.133	268.345	63.169	205.176		
October	13.6	93.328	154.914	248.242	61.928	186.314		
Total	94.8	894.488	1,290.102	2,184.590	535.065	1,649.525	3,071	2,937
1930								
July	28.8	291.012	371.394	663.006	163.615	499.391		
September	24.0	249.988	252.952	502.940	107.536	395.404		
Total	52.8	541.600	624.346	1,165.946	271.151	894.795	1,509	[3] 1,500
1931								
July	36.8	340.050	397.085	737.135	308.250	429.825		
September	8.8	82.755	125.008	207.763	83.054	124.708		
October	12.0	119.001	171.622	291.223	99.814	191.409		
Total	57.6	542.406	693.715	1,236.121	491.118	745.942	[3] 1,357	[3] 1,326

[1] Cut at first-heads-out stage.
[2] 368 pounds of silage was fed in September and 1,308 pounds was fed in October in addition to grain.
[3] Calculated from average content of total digestible nutrients in the hay for 1928 and 1929.

The number of days of grazing secured in the different years, and in the different months of the grazing season of each year, varied greatly according to the amount and distribution of rainfall. The number of cow-days per acre varied from 52.8 in 1930 to 94.8 in 1928 and 1929. The average for the 4 years was 75 cow-days. It will be recalled that the Sudan grass had been seeded on June 1, or as soon after that date as possible. The greatest amount of grazing in all four years was secured in July with a variation of from 28.8 cow-days in 1930 to 46.4 cow-days in 1928. In 1930 and 1931 there was no grazing in August, but the grazing was sufficiently good in that month during 1928 and 1929 to rank August third for the 4-year period in amount of grazing secured during the months included in

the grazing season. September provided some grazing in each of the 4 years, and October in 3 of the 4 years, but the average for the 4 years was only 11.5 cow-days, which is the lowest average for any of the 4 months. In order to provide continuous pasturage during these four months for a herd of cows, it would be necessary to provide a sufficient acreage per cow to permit a rotation from field to field, and even then it is doubtful whether continuous grazing could be secured in a year like 1930. Theoretically, it would have required 2.27 acres per cow to furnish continuous grazing for four months in 1930, while in 1928 and 1929 only 1.26 acres would have been required. The fact that more than half the pasturage is secured in

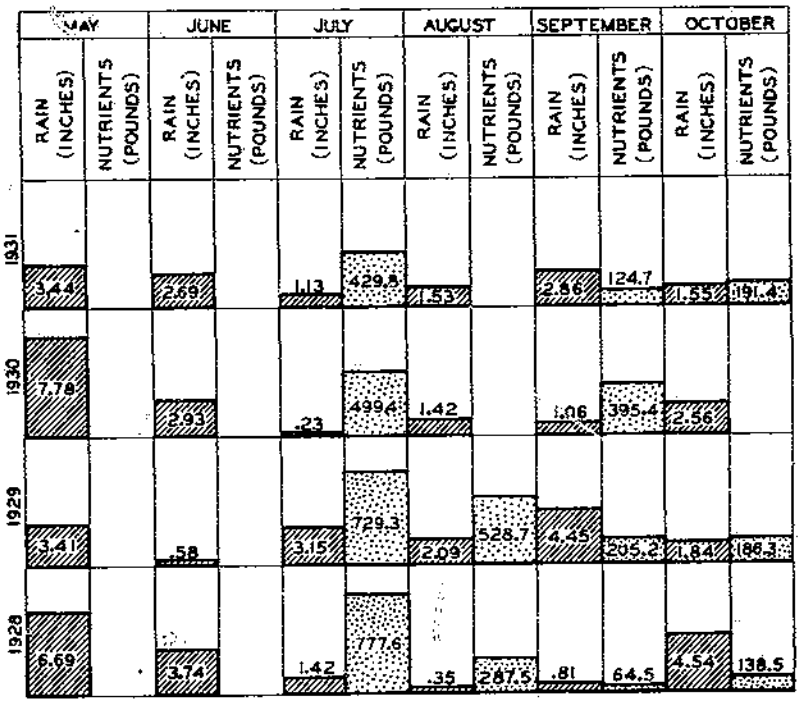

FIGURE 2.—Distribution of rainfall (inches) and calculated yield of total digestible nutrients (pounds per acre) of Sudan-grass pasture by months, in grazing experiments, 1928–1931

July, while the other half is fairly evenly distributed over August, September, and October, makes it difficult to secure continuous grazing even when a generous acreage per cow is allowed and rotation is practiced.

The amount of total digestible nutrients provided by an acre of Sudan-grass pasture corresponds very closely to the number of cow-days for the different years and for the different months. The variation in yields of total digestible nutrients by years and months furnished by the pasture is shown in Figure 2, together with the rainfall. The average yield of total digestible nutrients credited to the Sudan-grass pasture for the four years is 1,139.6 pounds per acre. The 4-year average also shows that 53 per cent of this total amount was secured in July, 17.9 per cent in August, 17.3 per cent in September, and 11.3 per cent in October. The average amount of total digestible

nutrients (1,139.6 pounds) secured from an acre of Sudan-grass pasture could be secured in 2,048 pounds of Sudan-grass hay, cut in the first-heads-out stage. As the average acre yields of air-dry hay cut at this stage of maturity for the four years was 3,667 pounds, it required only 0.56 acre of hay to produce as much total digestible nutrients as 1 acre of pasture furnished. However, there is an error in this calculation due to the fact that in the 1928 and 1929 feeding experiments an average of 17.7 per cent of the hay cut at first-heads-out stage was refused. This refusal was the coarser, stemmy portion of the hay that would be lower in nutritive value than that consumed. No analysis of the refused hay is available. If the 3,667 pounds of hay produced per acre is reduced by 17.7 per cent to conform to the edible portion, 3,018 pounds of edible hay was produced per acre for the 4-year average. On this basis, 0.67 acre of Sudan-grass hay cut in the first-heads-out stage produced the equivalent in edible nutrients of 1 acre of Sudan-grass pasture.

The results show clearly, however, that there is a close relationship between the production of nutrients in Sudan-grass pasture or hay and the distribution of rainfall during the growing months. The data also indicate that under conditions that obtained in the vicinity of Woodward, Okla., for the years 1928 to 1931, inclusive, approximately 33 per cent more edible nutrients were grown in the form of Sudan-grass hay cut at the first-heads-out stage than were secured by grazing Sudan grass with Holstein cows.

SUMMARY AND CONCLUSIONS

Data are presented giving the results of three years' experiments at the Woodward (Okla.) Dairy Experiment Station, on the yield, chemical composition, and comparative feeding value for milk production of Sudan-grass hay cut at four different stages of maturity. The yields of air-dry hay per acre at these different stages were surprisingly close by years, averaging 4,033 pounds for the first-heads-out stage, 3,925 pounds for the full-head stage, and 3,922 pounds for the soft-dough stage for the three years. The yield of hay cut every 30 days was only 3,043 pounds per acre in 1929, due to poor distribution of rainfall, but in 1930, it was practically the same as that for the other more mature stages. The yield is largely dependent upon the distribution of rainfall during the growing months. If sufficient moisture is available, as in 1929, three cuttings may be obtained from the first-heads-out stage, two cuttings from the full-head and soft-dough stages, and four cuttings from the 30-day-stage hay. If the rainfall during the growing months is poorly distributed, as in 1928, only one cutting of the typical stages as measured by head formation can be secured.

The chemical composition of Sudan-grass hay in general is closely correlated to the maturity of the plants when cut, and to a certain extent follows the number of days of growth. However, the distribution of rainfall (as it affects the growth of the plants) has considerable effect on the chemical composition. The average crude-protein content of the hays in the first cuttings only was 11.8 per cent for first-heads-out stage, 9.1 per cent for the full-head stage, 7.2 per cent for the soft-dough stage, and 13.5 per cent for that cut every 30 days. As the number of days of growth increased the percentages of protein and fat were depressed. In these experiments, the per-

centage of crude fiber showed a slight tendency to increase as the number of days of growth increased. The percentage of nitrogen-free extract increased steadily as the number of days of growth increased.

The yield of crude protein per acre, based on an average of the three years' results, was 403.6 pounds when the hay was cut at the first-heads-out stage, as compared to yields of 317.8 and 284.7 pounds when the hay was cut at the full-head and soft-dough stages, respectively, or an advantage of 27 and 42 per cent, respectively, in favor of the first-heads-out hay. It would require 1.27 acres of hay cut at the full-head stage and 1.42 acres cut at the soft-dough stage to yield as much crude protein as 1 acre cut at the first-heads-out stage. The hay cut every 30 days yielded an average of 363.6 pounds of crude protein per acre, for the two years' experiments with that stage.

In view of the slightly superior yield of air-dry hay per acre, higher crude-protein content, and much higher yield of crude protein per acre, the data show conclusively that Sudan-grass hay should be cut at the first-heads-out stage. However, there is some evidence—the higher crude-protein content of the 30-day-stage hay—to indicate that if rainfall distribution and other factors are such as to promote rapid recovery and growth so as not to lower the yield, a somewhat earlier stage of cutting Sudan-grass hay than the first-heads-out stage would be desirable from the feeding standpoint.

The superiority in chemical composition of the hay cut at the first-heads-out stage was borne out in the feeding trials with cows fed hay cut at the different stages. Considerably more of the first-heads-out hay was consumed than of the other stages, and less was refused. In fact, more of the first-heads-out hay was consumed than of first-class alfalfa, but more was refused. An average of the two years' feeding experiments shows that when approximately the same total amounts of hay were fed to the different groups of cows, they refused 17.7 per cent of the first-heads-out hay, 27 per cent of the full-head hay, and 24.3 per cent of the soft-dough hay. Apparently there was little difference in palatability of the hays cut at the two later stages. The higher palatability of the first-heads-out hay, however, increases materially the amount of edible air-dry hay and nutrients produced per acre when Sudan-grass hay is cut at that stage.

The first-heads-out Sudan-grass hay was superior to the hay cut at later stages of maturity in maintaining milk yield.

Results of two years' experiments in feeding Sudan-grass hay and Sudan-grass silage, cut in one year at the full-head stage, and in the other year at the first-heads-out stage, are reported. Cows fed full-head Sudan-grass hay and Sudan-grass silage in 1929 consumed a daily average of 10.4 pounds of hay and 76.5 pounds of silage containing 34.6 pounds of dry matter during the 42-day feeding period. Cows on full-head Sudan-grass silage alone consumed a daily average of 89.8 pounds containing 29.6 pounds of dry matter. The decline in milk production was 17.2 per cent for the former group and 14.7 per cent for the latter.

Cows fed first-heads-out Sudan-grass hay in 1931 consumed 34.5 pounds per cow a day, containing 31.1 pounds of dry matter. Their decline in milk production over the 42-day period was 9.4 per cent. Cows fed Sudan-grass silage cut at the first-heads-out stage consumed a daily average of 75.6 pounds per cow containing 24.9 pounds of dry

matter. Their decline in milk yield was 6.5 per cent for the 42-day period. The superiority of both the hay and silage cut at an immature stage over the full-head hay and silage is evident.

The data indicate that, pound for pound, the dry matter in the Sudan-grass silage was more valuable in maintaining the milk yield than was the dry matter in field-cured hay made from Sudan grass cut at the same stage of maturity.

The results of four years' experiments with Sudan-grass pasture as a grazing crop for dairy cattle are given, and the calculated yields of nutrients from grazing are compared with the yield of nutrients from Sudan-grass hay when cut at the first-heads-out stage. These grazing experiments again emphasize the close correlation of distribution of rainfall during the grazing months with the carrying capacity of the pasture in cow-days per acre and the calculated production of nutrients.

The grazing season averaged 100 days in length, but the total number of cow-days per acre varied from 52.8 in 1930 to 94.8 in 1928 and 1929, with an average of 75 for the four years.

More than 50 per cent of the grazing was obtained in July, and the remainder was fairly equally distributed between August, September, and October.

The calculated total digestible nutrients produced per acre by the pasture followed closely the carrying capacity in cow-days per acre. The average quantity produced per acre for the four years was 1,139.6 pounds. On this basis of calculation 0.67 acre of Sudan-grass hay cut in the first-heads-out stage produced the equivalent in edible nutrients of 1 acre of grazed Sudan-grass pasture. This is the equivalent of 33 per cent more nutrients secured per acre in the form of Sudan-grass hay cut at the first-heads-out stage than were secured from Sudan grass when grazed.

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