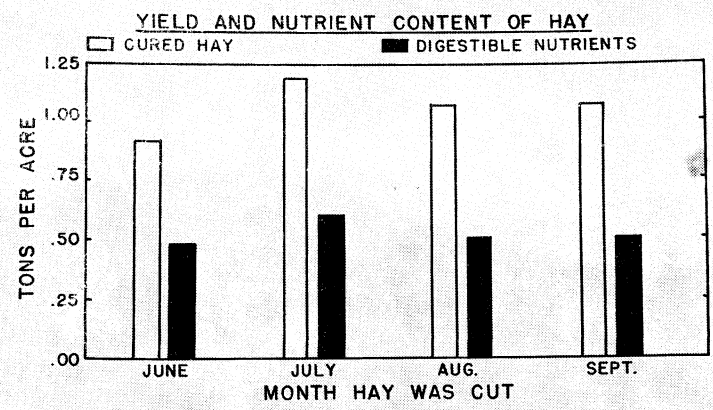

The Yield and Feeding Value of Prairie Hay as Related to Time of Cutting

By H. M. BRIGGS, W. D. GALLUP, and A. E. DARLOW

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The feeding value of forage plants changes continually as the plants grow and reach maturity. After maturity, the plants slowly lose in nutritive value due to weathering.** It is to be expected therefore that prairie hay will vary in feeding value according to the time of year when it is cut. This effect of time of cutting on feeding value of prairie hay has been investigated by the Experiment Station, and the results are described in this bulletin.†

Results varied somewhat with seasonal conditions, as would be expected. In general, however, they showed that:

1. June cuttings had the highest *feeding value per* POUND (total digestible nutrients, or T.D.N.).

2. July cuttings had the highest *feeding value per* ACRE. Hay cut in July had the highest average yield in tons per acre, and its T.D.N. per pound ranked next to June hay. Consequently, July cuttings gave the best combination of tonnage and feeding value per pound, and the greatest yield of total digestible nutrients per acre. (Figure 1).

3. Hay from all cuttings lost considerable amounts of carotene during the first six months of storage. Despite these losses, sufficient amounts remained at the end of the usual storage period (6 months) to make the hay a valuable source of vitamin A for livestock rations.

This research is being continued with the aim of finding what effect time of cutting may have upon the kind and stand of grasses and weeds in the meadow. Results of this work will be reported later.

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* Respectively: Animal Husbandman; Research Chemist; and Head, Department of Animal Husbandry. The authors are indebted to Clifford Kinney and J. S. Dinning for their capable assistance in caring for the animals and making collections during some of the digestion trials.

** See "Other Research Related to the Problem," page 10.

† Annual reports of results of this work have been made in the following publications of the Oklahoma Agricultural Experiment Station: Mimeo. Cir. M-136 (1945), Bulletin B-296 (1946), and Misc. Pub. MP-11 (1947).

How the Tests Were Made

The experimental plots used in this test were representative of a typical Oklahoma native hay meadow. The entire area had been in meadow for many years, except that for a year preceding the test it had been used as a pasture. The grasses were predominantly big and little bluestem, with a scattering of switch grass, sideoats grama, and Indian grass.

The test area was divided into four blocks. One plot from each block was mowed the third week of June, another the third week of July, a third the third week in August, and the fourth the third week in September. After field curing, the hay was raked with a side delivery, baled with a pickup baler, and stored in a hay loft. The hays made in 1944 and 1946 were stored without rain damage. Two of the 1945 crops had some rain damage. The June hay that year received one-half inch of rain between mowing and raking; and the September hay was thoroughly soaked by 14 inches of rain, over a two-week period, after it was raked into windrows.

Each year, hay from the different plots was compared as to yield, palatability, and content of major feed nutrients and of calcium, phosphorus, and carotene (the plant source of vitamin A). Differences in digestibility of the different lots of hay were determined by digestion trials with steers. Loss of carotene during winter storage of the hays was determined at monthly intervals. In addition, the late summer and fall grass (regrowth, or second-growth grass) produced on these plots after the hay was cut was analyzed for its content of feed nutrients.

Tonnage Yield

The yield per acre of the different cuttings of prairie hay is given in Table 1.* Variations in yield from year to year were due chiefly to variations in the amount and distribution of rainfall during the growing season.

Chemical Composition

The chemical composition of the hays cut is different months is given in Table II.

PROTEIN. The average protein content declined as the season advanced from June through August, but because of fall rains and consequent new growth the average protein content of September

* Tables will be found at the end of the bulletin, pp. 12 ff.

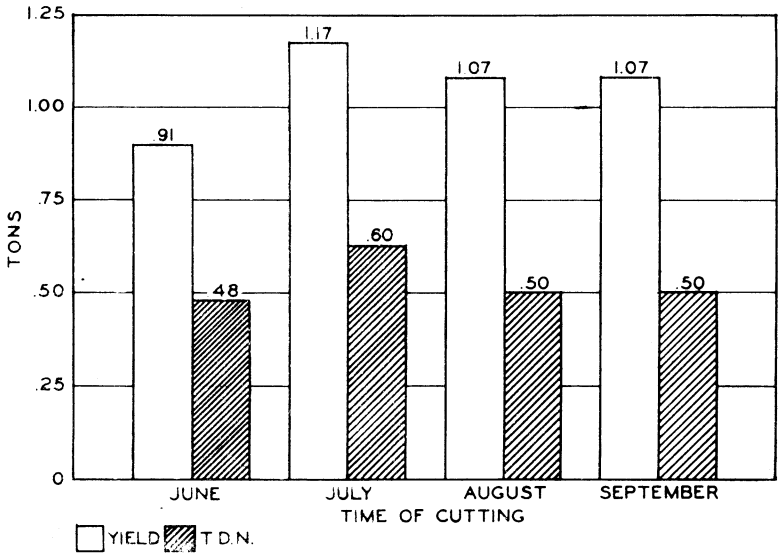

Fig. 1.—Average Yield and T.D.N. Per Acre of Prairie Hay Cut in June, July, August, and September.

Hay cut in July produced the largest tonnage of total digestible nutrients per acre, as well as the largest total yield. The June-cut hay had a somewhat higher feeding value per pound, but the July yield was enough greater to give July-cut hay the greatest feeding value per acre.

hay exceeded that of August hay. There was relatively less change in the other nutrient constituents.

CALCIUM AND PHOSPHORUS. Although differences between the hays in calcium and phosphorus content were small, it is noteworthy that the hays highest in protein were also highest in phosphorus but lowest in calcium. Non-legume hays are characteristically low in phosphorus, and when used in rations usually need supplementation with high phosphorus feeds.

CAROTENE. There was a marked reduction in the crude carotene content of the hays during the early part of the storage period. Most of the indicated loss occured during the first 30 days of storage. All the hays except those that suffered rain damage remained fair sources of carotene even after six months storage.

Digestibility and Nutrient Content

The digestibility of the hays and their calculated content of total digestible nutrients are shown in Table III.

In general it may be said that all nutrients in the June-cut hay were more digestible than those in hay cut later in the season.

With the single exception of June hay of 1944, however, none of the hays when fed at the rate of ten pounds daily provided sufficient protein to keep steers in positive nitrogen balance.

In one experiment (1944) the hays cut at the four different periods were each supplemented with 2.0 lbs. of cottonseed meal per steer daily. When the rations were supplemented, the digestibility of the nutrients in the hay was improved. These supplemented rations all resulted in positive nitrogen balances, with the steers storing from 15 to 28 percent of the nitrogen contained in the ration.

Palatability.

All hays appeared to be highly palatable, with the exception of the 1944 crop. The 1944 hay contained ungrazed forage left over from the previous year when the area was used as a pasture. Hay that was refused in the digestion trials was composed largely of this forage. When cottonseed meal was fed as a supplement, however, the 1944 hay was readily eaten.

Acre Yield of Total Digestible Nutrients.

Figure 1 gives average acre yields for both hay and total digestible nutrients. These data show that although June-cut hay was highest in *percent* of T.D.N. (Table III), the July cutting yielded enough more hay to put it first in *pounds* of T.D.N. per acre.

Value of Regrowth After Mowing.

The regrowth that occurs on Oklahoma hay meadows after the hay crop is harvested is often used for pasture. Table IV shows the chemical composition of this regrowth which is available as herbage for grazing animals. There was appreciable regrowth on the area cut in June, and a noticeable amount on the July-cut area. Very little regrowth takes place after August, and practically none after September.

There was a striking decrease in the protein content of regrowth from September to October, whether the area was mowed in June or July. This decrease is apparently due to seasonal maturity rather than the age of the plants.

SUMMARY

1. Prairie hay cut in June had a higher average protein and phosphorus content and a higher total digestible nutrient (T.D.N.) value than hay cut in July, August or September. The T.D.N. value of August-cut hay was below that of hays cut in the other months.

2. July-cut prairie hay produced the greatest yield of total digestible nutrients per acre because hay cut in that month had the highest average yield and also had a high feeding value per pound.

3. All cuttings of prairie hay were relatively high in calcium but low in phosphorus. Only one cutting (June, 1944) contained sufficient protein to maintain steers in positive nitrogen balance; when the other cuttings were fed without supplements, excretion of nitrogen (protein) by the steers exceeded their intake.

4. The freshly cut hays were high in carotene. When not damaged by rain after mowing, the hay after six months of storage still contained enough carotene to make it a reliable source of vitamin A for cattle.

5. Regrowth grass is high in protein and minerals in early fall but undergoes considerable change in composition as the dormant season approaches.

APPENDIX

Other Research Related to the Problem

Hopper and Nesbit (1930), working at the North Dakota Station, found that as prairie grass matured the protein content decreased and the crude fiber increased. Christensen and Hopper (1932), working at the same station, found that the digestibility of the nutrients in prairie grass declined as the season advanced. Crampton and co-workers in Canada (1939, 1940, 1944) found a seasonal change in herbage and a decline in the digestibility and nutritive value of pasture grass as the season advanced. Work at the Washington Experiment Station by Daniel *et al* (1946) indicated that as pea forage became more mature it was lower in digestibility.

McMillen, Williams and Langham (1943) studied western Oklahoma pastures and found that as the season advanced vegetative changes took place in pasture flora and that species changed in chemical composition and grazing value. Hobbs, Gallup, and Taylor (1945), working at this Station, found the apparent digestibility of dry matter, protein and crude fiber of prairie grass was lower in June than in July, August, and September. The grass was harvested from an old hay meadow and fed to steers in a digestion trial. Naturally the June harvested grass contained a higher percentage of regrowth of the previous year than the later cut grasses. Baker and co-workers (1947) harvested Nebraska grown prairie hay in July, August, and September and fed it to yearling heifers in a one-year trial. The tonnage yields of the hays for these months were 1.12, 1.43, and 1.51 tons, respectively, in 1945. The early cut hay proved most valuable in wintering yearling heifers.

Details of Experimental Procedure.

A native hay meadow which during the previous year had been used as a pasture was divided into four blocks of 2.34 acres each, and each block was subdivided into four plots. For three successive years, Series I plots were cut the third week in June and Series II, III, and IV plots were cut in the third weeks of July, August, and September, respectively.

Methods of cutting and storage, and rain damage, are described in the text (page 6).

The hays were weighed in January of the year following cutting to secure the cured yield. The chemical composition of the hay was determined by usual procedures (A.O.A.C. 1940). Crude carotene was determined by Peterson's (1941) modified procedure, and so called "true" carotene by chromatographic separation as described by Wall and Kelly (1943).

To determine the digestibility of the hays, four digestion trials were conducted each year with four yearling steers, each steer being fed a different hay cutting during each trial. Salt was the only supplement fed with the hay. All trials were equally divided into 10-day preliminary and 10-day collection periods. The general procedures followed in the collection and analysis of feeds and excreta have been previously described (Briggs *et al.* 1946).

The T.D.N. value of the different hay cuttings was calculated from the average results. Feces and urine were collected separately to obtain information on the efficiency of utilization of the nitrogen (protein) of the hays when fed without supplements. The results are expressed as nitrogen storage in Table III. The 1944 trials were repeated with 2 lbs. of cottonseed meal being fed as a supplement to 10 lbs. of hay. The results are shown in Table V.

Literature Cited

1. Association of Official Agricultural Chemists.
1940. **Official and Tentative Methods of Analysis.** Ed. 5, 757 pp. illus Washington, D. C.
2. Baker, Marvel L., V. H. Arthaud, E. C. Conrad and L. C. Newell.
1947. Effects of Time of Cutting on Yields and Feeding Value of Prairie Hay. Nebraska Agr. Expt. Sta. Bul. 385.
3. Briggs, H. M., W. D. Gallup, and A. E. Darlow.
1946. The Nutritive Value of Cottonseed Meal, Soybean Meal, and Peanut Meal When Used Separately and Together to Supplement the Protein of Prairie Hay in Experiments with Steers. **Jour. Agr. Res.** 73:167-176.
4. Christensen, F. W. and T. H. Hopper.
1932. Effect of Weathering and Stage of Maturity on the Palatibility and Nutritive Value of Prairie Hay. North Dakota Agr. Expt. Sta. Tech. Bul. 260.
5. Crampton, E. W., and R. P. Forshaw.
1939. The Intra-seasonal Change in the Nutritive Value of Pasture Herbage. **Sci. Agric.** 19:701-711.
6. Crampton, E. W., J. A. Campbell and E. H. Lange.
1940. The Relative Ability of Steers and Rabbits to Digest Pasture Herbage. **Sci. Agric.** 20:504-509.

7. Crampton, E. W. and I. R. C. Jackson.
1944. Seasonal Variation in Chemical Composition of Pasture Herbage and the Relation to its Digestibility by Steers and Sheep. (Pasture Studies—XXVI). **Jour. Anim. Sci.** 3:333-339.

8. Daniel, T. W., F. B. Wolberg, V. L. Miller, J. H. Alswager, M. E. Ensminger and A. A. Spielman.
1946. Chemical Composition and Digestibility of Flat Pea Forage in Three Stages of Maturity. **Jour. Anim. Sci.** 5:80-86.

9. Hobbs, C. S., W. D. Gallup and B. R. Taylor.
1945. The Composition and Apparent Digestibility of Bluestem Grass in the Growing Stage, and in the Dry and Hay Stages When Supplemented with Cottonseed Cake. **Jour. Anim. Sci.** 4:395-402.

10. Hopper, T. H. and L. L. Nesbit.
1930. The Chemical Composition of Some North Dakota Pasture and Hay Grasses. North Dakota Agr. Expt. Sta. Bul. 236.

11. McMillen, W. N. Quentin Williams, and Wright Laugham.
1943. Chemical Composition, Grazing Value and Vegetative Changes of Herbage in a Typical Plains Pasture. **Jour. Anim. Sci.** 2:237-243.

12. Peterson, W. J.
1941. Recent Developments in Methods for Determining Carotene. **Ind. and Eng. Chem., Anal. Ed.** 13:212-216.

13. Wall, M. E. and E. J. Kelley.
1943. Determination of Pure Carotene in Plant Tissue. **Ind. and Eng. Chem., Anal. Ed.** 15:18-20.

Table I.—The Yearly and Average Yields of Prairie Hay Cut in Different Months

Time of cutting hay	Yield per acre (tons)*			
	1944	1945	1946	Average
June	.79	1.09	.85	.91
July	1.26	1.20	1.06	1.17
August	1.00	1.36	.84	1.07
September	1.24	1.20	.76	1.07

*Weights taken January 1 of year following, to get cured yield.

Table II.—Chemical Composition of Prairie Hay Cut in Different Months.

Time of cutting hay	Year	Dry matter	Composition of hay (oven-dry basis)								
			Ash	Protein	Ether extract (fat)	Crude fiber	N.F.E.*	Ca	P	Crude Carotene	
										At time of storage	Stored 6 Mos.
		%	%	%	%	%	%	%	%	ppm**	ppm
June	1944	92.60	6.61	6.14	2.20	34.77	50.28	0.31	0.08	71.8	17.5
	1945†	94.33	6.92	5.77	1.93	33.94	51.44	0.36	0.07	34.6	10.0
	1946	93.45	6.70	5.25	2.11	33.37	52.57	0.38	0.07	63.5	18.7
	Av.	93.46	6.74	5.72	2.08	34.03	51.43	0.35	0.07		
July	1944	92.95	6.40	4.69	2.47	33.96	52.48	0.42	0.06	64.5	24.0
	1945	94.43	7.32	5.70	2.25	32.44	52.39	0.40	0.07	66.6	28.7
	1946	93.80	7.25	4.87	2.16	33.52	52.22	0.43	0.06	50.9	20.7
	Av.	93.73	6.99	5.09	2.29	33.31	52.36	0.42	0.06		
August	1944	92.79	7.04	3.80	2.44	32.80	53.92	0.41	0.04	27.3	18.5
	1945	93.92	6.88	4.70	2.19	34.24	51.99	0.41	0.06	73.2	29.3
	1946	93.17	6.94	4.13	2.66	34.46	51.81	0.56	0.05	31.5	18.3
	Av.	93.29	6.95	4.21	2.43	33.83	52.57	0.46	0.05		
September	1944	93.22	7.46	4.15	2.45	33.47	52.47	0.41	0.05	51.0	24.0
	1945†	94.25	7.06	4.05	2.14	35.03	51.72	0.42	0.05	8.7	6.0
	1946	93.18	6.91	5.40	2.53	35.37	49.79	0.49	0.06	70.3	31.0
	Av.	93.55	7.14	4.53	2.37	34.62	51.33	0.44	0.05		

* Nitrogen-free extract (soluble carbohydrates as starch, sugar, etc.)

** Parts per million

† In 1945 the June and September hays were damaged by rain before storage.

Table III.—Average Digestibility and Total Digestible Nutrient Content of Prairie Hay Cut in Different Months of 1944, 1945, 1946.

Time of cutting hay	Year	Daily feed		Nitrogen retained daily	Apparent digestibility of:					T.D.N.** of hay
		Hay Offered	Hay Refused		Protein	Ether extract (fat)	Crude fiber	N.F.E.*	Organic matter	
		lbs.	lbs.	gm.	%	%	%	%	%	%
June	1944	10.0	1.6	+1.5	41.2	47.9	69.0	62.2	63.1	55.7
	1945†	10.0	0.7	−4.1	26.5	29.4	60.5	50.9	52.9	46.7
	1946	10.0	0.2	−2.8	35.8	38.4	71.5	62.2	63.6	56.4
	Av.	10.0	0.8	−1.8	34.5	38.6	67.0	58.4	59.9	52.9
July	1944	10.0	2.0	−3.8	30.1	41.4	65.3	60.3	60.1	53.4
	1945	10.0	0.4	−4.5	28.4	29.2	62.6	56.2	56.3	49.9
	1946	10.0	0.2	−6.0	25.6	31.1	67.2	56.4	53.4	51.3
	Av.	10.0	0.9	−4.8	28.0	33.9	65.0	57.6	56.6	51.5
August	1944	10.0	3.1	−7.0	13.4	39.8	61.6	51.8	53.7	47.1
	1945	10.0	0.5	−6.9	20.2	26.2	58.9	51.2	51.9	46.0
	1946	10.0	0.1	−7.6	16.9	29.5	67.7	47.9	57.5	47.1
	Av.	10.0	1.2	−7.2	16.8	31.8	62.7	50.3	54.4	46.7
September	1944	10.0	2.6	−4.3	23.9	45.1	64.3	54.9	56.9	50.2
	1945†	10.0	1.6	−11.8	1.3	26.7	57.1	43.4	46.6	41.3
	1946	10.0	0.2	−7.4	23.4	33.3	65.4	53.9	56.0	49.5
	Av.	10.0	1.5	−7.8	16.2	35.0	62.3	50.7	53.2	47.0

* Nitrogen-free extract (soluble carbohydrates as starch, sugar, etc.)

** Values for T.D.N. on air-dry basis.

† Hays were damaged by rain before storage.

Table IV.—Chemical Composition of Second-Growth Grass.
(Oven-dry basis)

Period of growth	Ash	Protein	Ether extract	Crude fiber	N.F.E.	Ca	P	"True" Carotene
	%	%	%	%	%	%	%	ppm
1944								
June to Sept.	7.76	5.08	2.59	31.66	52.91	0.48	0.05	83.3
July to Sept	7.77	6.66	2.89	30.99	51.69	0.47	0.08	132.6
June to Oct.	7.70	3.75	2.39	32.44	53.72	0.36	0.05	44.5
July to Oct.	9.33	5.50	2.52	29.69	52.96	0.45	0.06	74.2
1945								
June to Sept.	7.35	5.22	2.53	31.89	53.01	0.44	0.05	48.1
July to Sept.	6.27	6.18	2.25	33.59	51.71	0.39	0.06	54.2
June to Oct.	7.61	3.27	2.14	34.86	52.12	0.44	0.03	23.2
July to Oct.	7.86	4.28	2.03	34.83	51.00	0.50	0.05	56.9
1946								
June to Sept.	8.16	7.27	2.22	30.98	51.37	0.47	0.09	86.4
July to Sept.	8.63	8.68	2.25	30.65	49.79	0.47	0.12	106.1
June to Oct.	8.43	4.09	2.17	32.08	52.23	0.39	0.04	8.5
July to Oct.	8.65	5.07	2.37	30.84	53.07	0.40	0.06	18.7

(1) "True" carotene by Wall and Kelly method.

Table V.—Average Digestibility of Rations of Prairie Hay and Cottonseed Meal.

Time of cutting hay	Daily feed		Nitrogen		Apparent digestibility of:				
	Hay	C. S. meal	Intake	Retained	Protein	Ether ext.	Crude fiber	N.F.E.	Organic
	lbs.	lbs.	gm.	gm.	%	%	%	%	%
1944									
June	10.0	2.0	94.4	23.8*	62.9	63.8	69.3	65.9	66.6
July	10.0	2.0	94.4	22.4	62.8	59.8	64.8	61.3	62.6
August	10.0	2.0	89.5	21.1	59.7	59.9	63.6	57.1	59.7
September	10.0	2.0	91.1	23.8	60.2	59.9	64.5	53.7	58.3

* Average of three trials. All other values are the average of four trials.