SOY BEAN VERSUS ALFALFA HAY FOR MILK AND BUTTER FAT PRODUCTION

by

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INTRODUCTION

Although alfalfa serves as the principal source of legume roughage in Kansas, in certain sections and under certain conditions the use of an annual legume becomes desirable. In 1931, 83,000 acres in Kansas were devoted to the production of annual legumes which were cut for hay, and of this area, approximately 15,000 acres were in soy beans with a value approaching $300,000. It is evident that winter killing, drouth, etc., will often make necessary the use of an emergency hay crop to replace alfalfa lost or decreased in yield by unfavorable weather conditions. A legume is preferred, and the soy bean has found a place in the southeastern portion of Kansas as such a crop.

According to the Biennial Report of the Kansas State Board of Agriculture (Vol. 27 pp 572-575) the acreage of soy beans used for hay in Kansas over the period 1927 to 1930, inclusively, has constantly increased. In 1927, 3,332 acres of soy beans were harvested for hay; in 1930 this acreage had increased to 10,230. The four southeastern counties of the State -- Crawford, Cherokee, Labette, and Neosho -- are the four highest producing counties, Labette and Cherokee having approximately 2,000 acres each in 1930.

Soy beans do well on light sandy soil and are quite drouth resistant. They were first given attention in the United States in 1868 (Hannan, 1919, p. 1) when the Mammoth Yellow variety was introduced. In 1924 there were 1,000,000 acres of soy beans grown for hay in the United States.

If the palatability of soy bean hay is maintained by obtaining a hay of good quality, its value is markedly enhanced. Palatability is influenced largely by the fineness of stem which is determined principally by the rate of seeding and time of cutting. The hay employed in this feeding trial was of good quality, coming from fields sown at the rate of 60 to 75 pounds of seed per acre and cut at the time the pods were well-formed but before the seeds were far developed.

CITATION OF LITERATURE

Soy bean hay was recommended as early as 1897 by the United States Department of Agriculture (Farmers' Bulletin 58) at which time it was pointed out that the hay was often very coarse and, if not cut at the proper season, was lacking in leaves.

Duggar (1908 pp 19-23) compared cowpea hay and soy bean hay, finding that soy bean hay produced 3.5 per cent more milk and 4.5 per cent more butter fat than did cowpea hay. Approximately 32 per cent of the soy bean hay was refused

which indicates that it was of poor quality.

Price (1908 pp 35-40) compared soy bean and alfalfa hay for milk production and found that the cows when on the alfalfa ration consumed 21.9 per cent more total digestible nutrients per 100 pounds of milk produced and 33.2 per cent more total digestible nutrients per pound of butter fat produced than when on the soy bean hay ration.

Hunziker and Caldwell (1917 pp 5-6) in a comparison of soy bean and alfalfa hay found alfalfa to be 18 per cent more valuable than soy bean hay as a milk-producing roughage. When the cows were fed soy bean hay the milk production decreased but the fat content increased, resulting in the production of more butter fat on the soy bean hay ration.

Anthony and Henderson (1923 p. 10), Olson (1923 p. 15), and Beohdel (1926 p. 15) found soy bean hay slightly superior to alfalfa hay for milk and butter fat production.

Hart et al (1926 pp. 130-31) concluded that soy bean hay was 73 per cent as efficient as alfalfa hay, though in milk and butter fat production they were equal. The soy bean hay was considered less efficient because of the large amounts wasted and the loss in body weight occurring when it was fed.

Moore and Cowsert (1926 p. 8) found that though soy bean hay produced 0.6 per cent less milk, it produced 4.80 per cent more butter fat than did alfalfa hay. The cows lost

body weight on the soy bean hay but showed a gain in weight on the alfalfa.

Nevins and Tracy (1928 pp. 479-488) report that neither high quality nor low quality moldy soy bean hay was found to have any effect upon the flavor of milk (raw or pasteurized), skim milk, cream, or butter. Ground soy beans caused the body of the butter to be gummy, and soy bean hay had a similar effect but to a less degree.

Morrow and La Master (1929 p. 28) found that grinding increases the palatability of soy bean hay, as did Ingham and Meade (1929 p. 17) who also conclude that ground hay is more effective for milk and butter fat production and for the maintenance or increase of body weight.

Hilton, Wilbur, and Epple (1931 pp. 18-21) found that soy bean hay cut when the pods were completely formed, the beans well formed, and the lower leaves turning yellow was superior for both milk and fat production to hays cut in earlier stages of maturity. On the basis of production per acre, late-cut hay produced about 19 per cent more milk and 39 per cent more fat than early-cut hay. To a lesser extent it was also superior to the intermediate-cut hay. There was practically no difference in the effect on body weight. The cows refused 3 per cent of the early-cut hay, 5 per cent of the intermediate-cut hay, and 5.4 per cent of the late-cut hay.

Warren (1928 pp. [illegible]-23) found that soy bean hay was equal to or slightly better than alfalfa hay for milk and butter fat production though not as effective in maintaining body weight. The per cent of fat was significantly greater on the soy bean hay ration.

Bray (1929 p. 15) concludes that soy bean hay of good quality is equal to alfalfa hay for milk and butter fat production or for maintaining body weight. He found no increase in per cent of fat when soy bean hay was fed.

EXPERIMENTAL PLAN

Object of the Experiment

The object of this feeding trial was to compare soy bean hay with alfalfa hay as a roughage for cows in milk.

Cows Used

Ten cows (six Ayrshires, two Jerseys, and two Guernseys) were selected from the college herd for use in the experiment and were divided into two groups of five cows each. The groups were balanced as nearly as possible in regard to breed, body weight, daily milk production, per cent of fat, age, stage of lactation, stage of gestation, and previous production. Information concerning the animals used is given in Table I, and it will be noted that the two groups are quite evenly balanced in regard to the factors indicated

in the table. However, this balance was somewhat disturbed when one cow from each lot (numbers 455 and 465) had to be dropped from the experiment because of udder trouble.

Duration

This experiment was of ninety days duration, extending from October 27, 1931 to January 24, 1932, inclusive. The time was divided into three 30-day periods, the first ten days of each period being considered preliminary, and data from these preliminary periods were not included in the experimental results.

Housing and Exercise

Standing in regulation stanchions in the northwest corner of the college dairy barn, the cows were maintained under conditions as near the normal as possible. When weather permitted they were given access to a dry exercise lot. During the first 30-day period they were outside much of the time, but throughout the second and third periods they were confined to the barn because of inclement weather.

Method of Feeding and Watering

All feeds were weighed to each individual cow morning and evening in specially constructed experimental mangers. Refused feed was weighed back and deducted from the total.

The stalls were equipped with individual drinking cups and a tank of fresh water was available whenever the cows were in the exercise lot.

Body Weights of Cows

Body weights were secured at the beginning and end of each experimental period, the first and last days of each period being the center of the three weigh days. The weights were taken between seven and eight A. M. in every case. The average of differences in body weight between the beginning and end of each period was the value employed in calculating all changes in body weight.

Milk Weights and Per Cent of Butter Fat

Milk weights for each milking were kept for each individual cow. The cows were milked by machine twice daily at regular twelve-hour intervals. The per cent of butter fat was determined for each cow by calculating the true average test from representative samples of six milkings at the center of each experimental period.

Feeds Used

A. M. variety soy bean hay of exceptionally high quality, grown on the college farm, was used in the trial. It was fine stemmed, leafy, and of a high green color. The alfalfa hay was of average quality being somewhat high in

crude protein — 10.10 per cent. The grain mixture used was composed of four parts by weight of yellow corn, two parts wheat bran, and one part linseed meal. Kansas Orango sorgo silage of normal composition and quality was used throughout the trial. One per cent each salt, steamed bone meal, and ground limestone was added to the above grain mixture.

Composition of Feeds

A composite sample of soy bean hay was secured from each 30-day period and was analyzed in the experiment station feed analysis laboratory. Composite samples from the alfalfa hay, the silage, and the grain mixture were collected and were analyzed at the end of the trial. The samples of hay were taken at the time of grinding and of the grain at the time of mixing. Silage samples were taken directly from the silo. The composition of the feeds used is shown in Table IV.

Determination of Digestible Nutrients

The digestible nutrients of any feed constituent were determined by multiplying the per cent composition of that constituent by its coefficient of digestibility as reported by Henry and Morrison (1908, Appendix, Table II).

Rations Fed

All the cows were fed the basal ration of sorgo silage and the 4-3-1 grain mixture. Group I was fed soy bean hay during the first and third periods and alfalfa hay during the second period. Group II was fed alfalfa hay during the first and third periods and soy bean hay during the second period.

Methods of Computing Rations

The nutrient requirements of the animals were calculated for each experimental period. They were determined from the body weights and the average of five days production of each cow taken during the preceding 10-day preliminary period. The per cent of fat used for the first period for each cow was her monthly fat test of the preceding month and for the later periods was her average test of the prededing period.

The rations were computed according to the requirements set forth in the Morrison feeding standard for dairy cows. The maximum amount of digestible crude protein and the minimum amount of total digestible nutrients as shown by the standard were supplied so that as much hay as possible might be fed.

Notes

Daily observations were made and complete notes regarding the cows and the conditions of the experiment were kept.

EXPERIMENTAL RESULTS

Feed Consumed

Tables III and VI show the consumption of feed, Table VI showing that the average feed consumption in Periods I and III for Group I was 2360 pounds of silage, 660 pounds of grain and 981 pounds of soy bean hay, containing 212.1 pounds of digestible crude protein and 1346.81 pounds of total digestible nutrients. During Period II the feed consumption for the same group was 2380 pounds of silage, 640 pounds of grain, and 960 pounds of alfalfa hay. The digestible nutrients contained in this feed was slightly less than the average for the other two periods, being 206.8 pounds of digestible crude protein and 1309.48 pounds of total digestible nutrients. Group I while on soy bean hay consumed on an average 5.3 pounds more digestible crude protein and 36.73 pounds more total digestible nutrients than when on alfalfa hay.

The average consumption of Group II during Periods I and III was 2260 pounds of silage, 540 pounds of grain, and 930 pounds of alfalfa hay, containing 190.04 pounds of digestible crude protein and 1208.96 pounds of total digestible nutrients. During period II this group consumed 2240 pounds of silage, 500 pounds of grain, and 940 pounds of soy bean hay, which furnished 183.76 pounds of digestible crude protein and 1201.18 pounds of total digestible nutrients. Group II, then, while being fed soy bean hay consumed 6.28 pounds less digestible crude protein than during the two alfalfa periods and received 7.78 pounds less total digestible nutrients.

Body Weights of Cows

In Table II the body weights of the individual cows and body weights by groups are summarized. Group I gained a total of 135 pounds on soy bean hay and lost 64 pounds on alfalfa hay, while Group II, quite to the contrary, gained 139 pounds on alfalfa hay and lost 18 pounds on soy bean hay. The loss in weight by both groups during the second experimental period may be accounted for in part by the fact that the final weights were taken during the first extremely cold weather which may have discouraged normal water consumption on the days body weights were taken. In any case, neither hay shows a significant advantage over the other in

maintaining body weight.

Milk and Butter Fat Produced

As shown in Table VI, Group I while on soy bean hay produced an average of 1650.2 pounds of milk and 77.388 pounds of butter fat. During Period II on alfalfa hay the same group produced 1708.7 pounds of milk containing 75.140 pounds of butter fat, making a difference of 31.5 pounds of milk and 2.838 pounds of butter fat in favor of the soy bean hay. These results are shown graphically in Figures I and II. The average per cent of fat in the milk produced on soy bean hay was 4.23 while on alfalfa hay it was 4.17.

Group II produced an average of 1542 pounds of milk containing 61.968 pounds of butter fat during Periods I and III when alfalfa hay was being fed. During period II with soy bean hay in the ration this group produced 1454.1 pounds of milk containing 64.984 pounds of butter fat, making a difference of 87.9 pounds of milk in favor of alfalfa and a difference of 2.921 pounds of butter fat favoring soy bean hay. The per cent of fat on soy bean hay was 4.468 while on alfalfa it was 4.031. A summary of the milk and butter fat production of the individual cows is shown in Table V.

Nutrients Consumed per Unit of Production

The efficiency in milk and butter fat production of soy bean hay as compared to alfalfa hay, both as a source of digestible crude protein and as a source of total digestible nutrients, is shown in Table VII.

In Group I soy bean hay was 98.2 per cent as efficient a source of digestible crude protein and 97.84 per cent as efficient a source of total digestible nutrients as was alfalfa hay for milk production. In Group II for milk production soy bean hay had an efficiency of 98.73 per cent as a source of digestible crude protein and 98.85 per cent as a source of total digestible nutrients, as compared with alfalfa. The two groups give soy bean hay an average efficiency as a source of digestible crude protein for milk production 98.46 per cent that of alfalfa and as a source of total digestible nutrients for milk production 98.84 per cent that of alfalfa.

In the production of butter fat Group I showed soy bean hay to have an efficiency as a source of digestible crude protein 99.65 per cent that of alfalfa and as a source of total digestible nutrients 99.15 per cent that of alfalfa. Group II on a basis of butter fat production showed soy bean hay to be 109.18 per cent as efficient as alfalfa as a source of digestible crude protein and 105.58 per cent as efficient

as a source of total digestible nutrients. Averaging these groups we find that in the production of butter fat soy bean hay is 104.4 per cent as good a source of digestible crude protein and 102.36 per cent as good a source of total digestible nutrients as is alfalfa hay.

Per Cent Butter Fat in Milk

Conclusions of other investigators that soy bean hay tends to increase slightly the per cent fat in milk were borne out by this trial. Group I while on soy bean hay maintained an average test of 4.2319 per cent fat -- .0539 per cent greater than the test of 4.178 per cent fat on alfalfa hay. Group II while on soy bean hay had an average test of 4.[illegible] per cent fat, while on alfalfa hay the test was 4.0313 per cent fat -- a difference of .4508 per cent in favor of soy bean hay. The difference in test for the two groups averaged .2423 per cent fat in favor of soy bean hay, an increase of 6.01 per cent.

Experimental Notes

Two cows, numbers 466 and 468, had to be dropped from the experiment because of digestive disturbances and udder trouble. As both were Guernseys, one from each group, the major difficulty which this necessary adjustment caused was the effect on the comparative production of the two groups.

Results should be interpreted with an appreciation of the fact that Group I had a higher average production than Group II. Aside from the trouble with these two cows the experiment progressed smoothly with no refused feed and no cows off feed. It was observed, however, that after the cows had been receiving soy bean hay about seven days they ate their hay with less apparent relish. By the end of the period those cows receiving soy bean hay required an extra hour to clean up the hay in their mangers.

CONCLUSIONS

1. While soy bean hay proved slightly less efficient than alfalfa hay on the basis of digestible nutrients consumed per unit of production in the production of milk, the increase in per cent fat was sufficient to make it slightly more efficient in fat production than was alfalfa hay.

In the production of 4 per cent fat corrected milk soy bean hay was slightly more efficient than alfalfa hay both as a source of digestible crude protein and as a source of total digestible nutrients.

These differences do not seem to be significant, however, and the two hays are considered practically equal as roughages for cows in milk.

2. Neither hay appeared to be more valuable than the other in maintaining body weights.

3. Soy bean hay tends to increase slightly the per cent butter fat in the milk.

4. The soy bean hay used in the trial although of good quality was apparently less palatable than was the alfalfa hay.

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TABLE I

Descriptive Summary of Cows Used

Group I

Number of Cow	Breed	Age		Weight	Lactation days	Gestation days	Daily Milk Pounds	Per Cent Fat
		Yrs.	Mo.					
286	Ayrshire	6	2	1032	59	open	25.2	4.22
296	Ayrshire	4	8	1093	65	open	38.8	4.14
208	Ayrshire	3	2	979	42	open	25.3	4.24
359	Jersey	3	10	850	55	open	20.2	5.16
455	Guernsey	6	8	952	71	open	21.6	4.40
Average		4	11	977	58	open	26.2	4.63

Group II

210	Ayrshire	3	1	1010	41	open	27.0	3.59
295	Ayrshire	5	2	1050	51	open	32.3	3.74
203	Ayrshire	3	8	1083	38	open	25.3	3.85
347	Jersey	6	7	925	55	open	20.7	5.14
465	Guernsey	4	10	862	56	open	30.7	5.00
Average		4	8	976	57	open	27.2	4.06

TABLE II

Summary of Body Weights

Group I

Number of Cow	Period I Soy Bean Hay			Period II Alfalfa Hay			Period III Soy Bean Hay		
	Wt. at Begin- ning lb.	Wt. at End lb.	Gain or Loss	Wt. at Begin- ning lb.	Wt. at End lb.	Gain or Loss	Wt. at Begin- ning lb.	Wt. at End lb.	Gain or Loss
286	1084	1090	36	1077	1066	-11	1106	1117	11
296	1063	1140	57	1103	1101	-02	1146	1134	-12
389	850	816	-04	840	810	-33	861	872	11
308	950	969	19	969	972	-18	998	969	-33
Total	3997	4050	108	4019	3949	-84	4109	4092	-83

Group II

	Alfalfa Hay			Soy Bean Hay			Alfalfa Hay		
210	1006	1026	19	1014	1019	05	1030	1037	12
295	1038	1050	12	1095	1046	-09	1027	1063	36
347	916	944	28	939	930	-09	951	963	12
303	1036	1040	04	1040	1040	-09	1065	1079	15
Total	3995	4060	63	4088	4035	-18	4073	4139	66

TABLE III

Feed Consumption

Period I

Group I	Feed in Pounds	D. C. P. in Pounds	T. D. N. in Pounds	Group II	Feed in Pounds	D. C. P. in Pounds	T. D. N. in Pounds
Silage	2400	18.85	352.16	Silage	2280	17.90	334.53
Grain	680	83.10	496.35	Grain	600	73.33	437.96
Hay-Soy Bean	960	116.54	527.08	Hay-Alfalfa	920	105.75	478.01
Total		218.49	1375.59			196.98	1250.50

Period II

Silage	2320	18.22	343.53	Silage	2210	17.59	328.67
Grain	640	78.22	467.15	Grain	500	61.11	364.97
Hay-Alfalfa	960	110.35	498.80	Hay-Soy Bean	940	105.06	507.54
Total		206.79	1309.48			183.78	1201.18

Period III

Silage	2320	18.22	343.53	Silage	2240	17.59	328.67
Grain	640	78.22	467.15	Grain	480	58.66	350.36
Hay-Soy Bean	943	109.32	506.36	Hay-Alfalfa	940	108.05	488.40
Total		205.76	1317.04			184.30	1167.43

TABLE IV

Composition of Feeds

Period I

	Per Cent of Moisture	Per Cent of Protein	Per Cent Fat	Per Cent Fiber	Per Cent Ash	Per Cent N.F.E.
Alfalfa Hay	8.09	16.19	1.71	29.26	8.46	37.29
Soy Bean Hay	6.26	16.23	2.98	30.00	8.63	35.42
Grain	10.80	15.01	4.26	4.13	5.75	59.19
Kansas Orange Sorgo Silage	72.44	1.84	.76	7.43	2.63	13.47

Period II

Soy Bean Hay	8.41	15.91	2.15	30.98	8.97	34.60

Period III

Soy Bean Hay	8.48	16.88	2.35	29.58	8.80	34.71

TABLE V

Summary of Milk and Fat Production

Group I

Number of Cow	Period I (Soy Beans)			Period II (Alfalfa)			Period III (Soy Bean)		
	Milk Pounds	Per Cent Fat	Fat Pounds	Milk Pounds	Per Cent Fat	Fat Pounds	Milk Pounds	Per Cent Fat	Fat Pounds
396	436.8	3.23	14.072	377.6	3.44	12.986	384.4	3.33	11.130
396	714.0	3.98	28.302	641.0	3.95	25.307	590.3	3.85	22.549
389	333.5	7.14	23.815	322.2	6.49	19.435	258.6	7.95	20.381
398	866.8	2.80	19.814	477.9	3.01	17.888	436.2	3.36	14.736
Total:	2347.1	4.50	84.003	1798.7	4.15	75.180	1613.4	4.34	68.774

Group II

	(Alfalfa)			(Soy Bean)			(Alfalfa)		
210	488.5	3.20	15.906	427.9	3.54	16.873	434.7	3.40	14.780
293	570.8	3.68	21.006	461.6	4.08	18.713	456.2	3.85	17.545
347	304.3	5.60	16.040	283.6	7.17	10.178	217.3	6.53	14.194
203	307.6	3.86	13.003	271.0	4.21	11.420	252.6	3.90	9.851
Total:	1733.2	3.98	67.884	1454.1	4.46	64.884	1360.8	4.14	56.370

TABLE VI

Summary of Feeds, Digestible Nutrients, Production and Body Weights

Group I

	Silage: Pounds	Grain: Pounds	Hay: Pounds	D.C.P.: Pounds	T.D.N.: Pounds	Milk: Pounds	Fat: Pounds	Per Cent Fat	Gain or Loss in Body Wt.
Averages Periods I & III									
Soy Bean:	8360	660	901	812.1	1548.21	1830.8	77.[illegible]	4.[illegible]	125
Period II									
Alfalfa	8180	640	920	806.9	1509.68	1798.7	75.150	4.18	-80
Differences	40	20	9	5.2	38.73	31.0	2.[illegible]	.05	173

Group II

Averages Periods I & III									
Alfalfa	8360	640	930	830.64	1538.98	1848.0	81.[illegible]	4.[illegible]	120
Period II									
Soy Bean:	8240	599	940	783.73	1501.18	1684.1	66.[illegible]	4.46	-10
Differences	80	40	10	6.88	7.78	57.9	2.[illegible]	.43	167

TABLE VII

Digestible Crude Protein and Total Digestible Nutrients Required Per Unit of Production

Group I

	Soy Bean (Average 2 periods)	Alfalfa	Efficiency of Soy Bean (Alfalfa-100%)
D. C. P. per 100 lbs. Milk	11.71	11.50	98.80
T. D. N. " 100 lbs. Milk	74.41	72.20	97.04
D. C. P. " pound of fat	.76	.75	99.63
T. D. N. " " " "	17.87	17.48	90.15
D. C. P. Per 100 lbs. 4% F. C. Milk	11.20	11.00	100.00
T. D. N. " " " " F. C. "	71.12	70.01	100.30

Group II

D. C. P. per 100 lbs. Milk	12.04	12.40	98.73
T. D. N. " " " "	82.00	79.17	95.85
D. C. P. " pound of fat	2.83	3.09	109.13
T. D. N. " " " "	18.51	19.00	106.56
D. C. P. " 100 lbs. 4% F. C. Milk	11.02	12.33	104.51
T. D. N. " " " " F. C. "	77.05	78.19	101.28

TABLE VII - Continued

Average of Two Groups

	Soy Bean (Average 2 periods)	Alfalfa	Efficiency of Soy Bean (Alfalfa-100)
D. C. P. per 100 lbs. Milk	12.17	11.99	98.46
T. D. N. " " " "	78.50	78.93	90.06
D. C. P. " pound of Fat	2.79	2.92	104.40
T. D. N. " " " "	18.04	19.81	109.86
D. C. P. " 100 lbs. 4% F. C. Milk	11.51	11.76	102.15
T. D. N. " " " " F. C. "	74.18	74.90	100.76

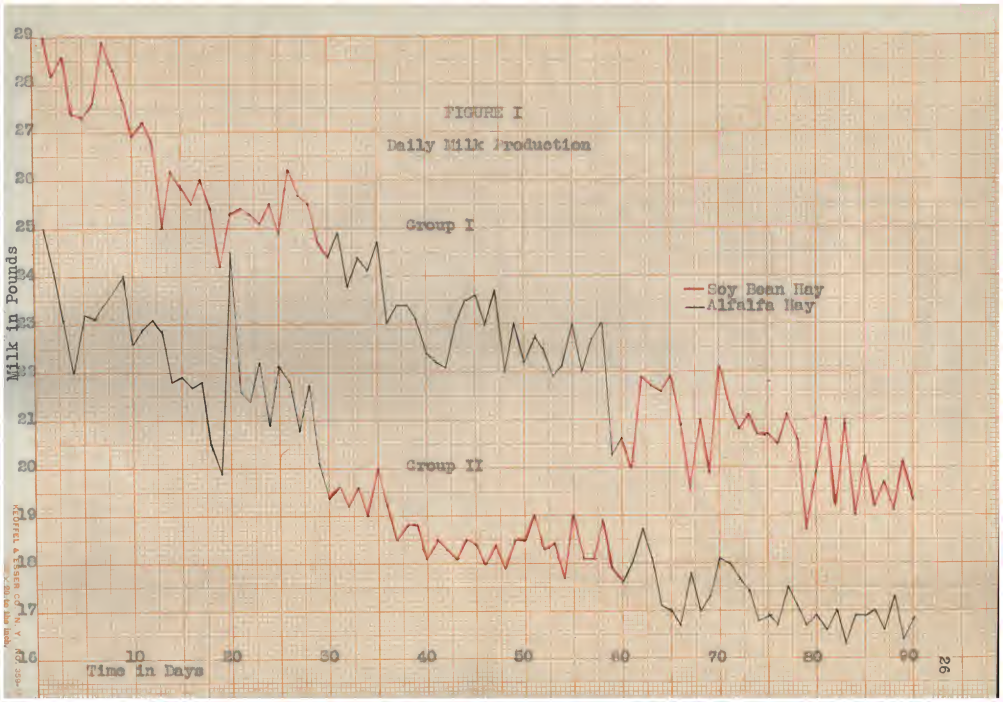
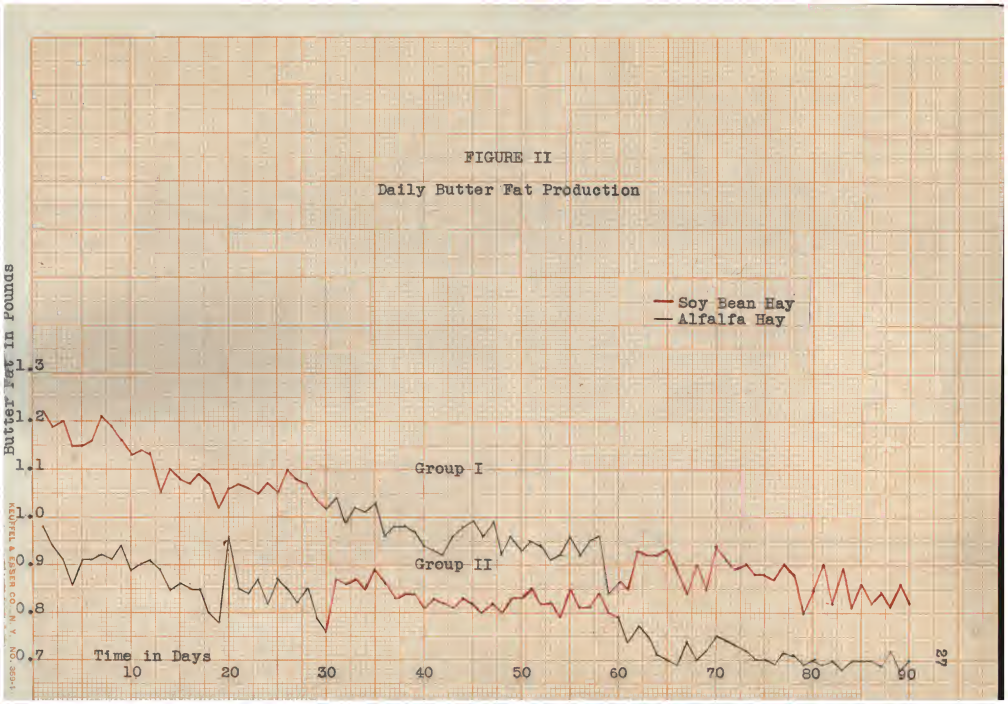


FIGURE I
Daily Milk Production
Group I
Group II
Soy Bean Hay
Alfalfa Hay
Milk in Pounds
Time in Days
10
20
30
40
50
60
70
80
90

FIGURE II

Daily Butter Fat Production



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