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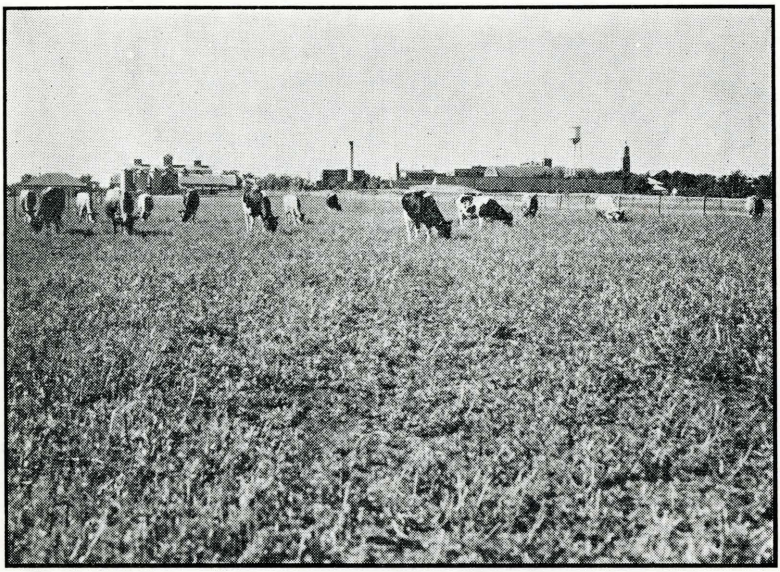

Cows on Sweet Clover Experimental Plot

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Ten Years of Experimental Results on Cultivated Pastures

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A series of cultivated pasture-trials were started in 1927. The original plan was to continue the trials for several seasons to obtain data on such pasture plants as alfalfa, sweet clover, and sudan grass. Because of the abnormally dry seasons, including several drought years, the work has been extended until ten pastures seasons have been included.

This bulletin reports the results for the 10 years. The results are not as favorable to these pasture crops as they would have been had the moisture been more abundant. Every year in the ten the lack of moisture curtailed the amount of pasture available. Just what might be expected from these pastures with adequate moisture is unknown. It is, however, safe to assume that an appreciable increase in production would have resulted if sufficient moisture had made possible continuous pasturing during the entire pasture season. The trials will be continued for several more pasture seasons in the hope of including one or more seasons in which the moisture is not the limiting factor.

Three plots of permanent pasture mixtures have been included in this experiment. To date no data are available from these plots because of an insufficient stand to justify pasturing.

Review of Literature on Pastures

Importance of Pasture.—Good pasture furnishes an important and economical source of nutrients for milk production during the summer months.

Dawson(1), Lush(2), Beeson and Pence(3), Graves, Dawson, Kopland, and Moseley(4) have shown by experimental work that pastures provide the cheapest source of milk production nutrients. Lush(2) found that the feed cost of butterfat was 13 cents per pound less on pasture than on dry feed.

These workers pointed out the higher protein content of early spring pasture, and its stimulating effect on milk production. They also cautioned against too early pasturing because of the high moisture content (80 per cent or higher) of early spring pasture, and therefore forcing the cows to graze over a larger area in order to satisfy their nutrient requirements. Graves(4) and associates found that a cow producing 35 pounds of milk per day must gather and consume 275 to 300 pounds of early spring grass to get enough feed for her requirements. However good pasture would provide sufficient nutrients for this production.

Woodward and Graves(5) found that pasture grass varied in nutritive composition at different stages of maturity. The immature grass had a composition that made it more efficient for milk production than the mature grass. The most rapid growth occurred early in the growing season, but climatic condition had a greater influence than any other factor.

Parsons(6) found that it cost slightly more to produce 100 pounds of milk on fertilized plots than on non-fertilized plots, but on account of the greater quantity produced on the fertilized plots they showed larger receipts per unit of area.

Hodgson(7) found that any improvement in pasture management that will cause lactating cows to obtain their substance with a minimum of

grazing will conserve their energy for milk production. In this connection he found that cows subjected to rotational grazing spent less time grazing and more time lying down than cows on an open pasture.

Lush(8) found that cows full fed on grain did not show as great a drop in production after June as those on a low or limited grain ration. His results indicated that ground corn and oats might be most economical for early spring, but that this should be supplemented with good quality protein feed during summer and early fall pastures.

Methods of Pasture Management.—Three systems of pasturing are practiced. They are (1) continuous, (2) rotational, and (3) deferred. In the continuous system the animals graze the entire pasture area without any attempt being made to control the movement of their grazing habits. The deferred system of grazing necessitates the use of two or three pastures. Grazing is delayed in one pasture for six to eight weeks at the beginning of the season. By this time there will be a very good growth to support grazing during July and August, after which the cows will be turned back on the first pasture. In the rotational system the pasture area is fenced in to several smaller areas, which are grazed one at a time, the others being rested and the vegetation allowed to grow between periods of grazing.

Comfort and Brown(9) after studying all three systems concluded that the larger yields of grass from rotation pasture was an indication that this system of grazing had a beneficial effect on the growth. They found that 1.48 acres of blue grass in Missouri would support a heifer under both the rotational and continuous systems and 1.17 acres were sufficient under the deferred.

Hodgson et al(10) concluded that in western Washington the additional yield of nutrients did not pay for the extra cost of rotational grazing. They found no improvement in the chemical composition of the pasture.

Salter and Yoder (11) found under the Hohenheim system, which involves division of the pasture area into plots, use of concentrated fertilizers and rotational grazing, that a pasture which normally carried from 0.66 to 0.80 cows per acre in a normal year was able to support 1.82 cows per year of extreme drought under this system. They found that the Hohenheim system (1)lengthened the grazing season by about three weeks, (2) increased the protein content of the herbage and total production of both protein and dry matter, (3)increased carrying capacity per acre with corresponding decrease in grazing area required, (4)reduced feed supplement, and (5)increased density of turf.

The disadvantages were: (1)a relatively high acre cost, (2)need for skillful grazing management, and (3)the difficulty of maintaining white clover in the herbage.

Aldous(12) reported that stock in Kansas gained 84 pounds per acre under the deferred system and 54 pounds under the continuous system. The 12 year average for continuous grazing was 4.93 acres per head, for the deferred system 3.43 acres per head.

Control of weeds.—The presence of weeds in pasture is usually due to improper grazing or to lack of some soil nutrient. Pastures which are properly grazed and well fertilized are not as a rule, badly infested with weeds. Many methods of weed control have been tried, such as (1)cultivation, (2) mowing, (3) grazing management, (4) chemical, and (5) burning. The two methods which have met with the greatest success are mow-

ing and grazing management. To destroy weeds by mowing it is important to do so at the right stage of developement.

In Texas(13) a pasture area badly infested with bitterweed was mowed on May 21 when the plant was in the late bloom stage. As a result the area produced an 80 per cent grass-cover during the summer, while the surrounding unmowed area remained practically barren as far as grass was concern. On plots mowed earlier when the plants were about 90 per cent in bloom it was found that within two weeks, 50 per cent of the weeds had branched out from the roots and new growth was evident.

As the weed begins to grow in the spring it draws on the food in the roots and this continues until there are sufficient leaves to produce food for growth. At this time the plant begins to replace the food supply stored in the roots. It is necessary to mow the weeds at the time this food supply in the roots is the lowest in order to get the most destruction. This date varies with different species. With some it occurs in May or June, in others as late as July or August. Most weeds require two or three cuttings for complete eradication.

Systems of Grazing Management Affect Weed Growth.—Pastures which are overgrazed or grazed too early in the spring afford excellent opportunities for weed growth. Grazing animals will pick out the grasses and leave the weeds to grow unchecked. Given a chance to start growth the weeds soon shade the ground and prevent the grasses from getting a start.

Chemicals, especially chlorates, can often be used to control small patches of weeds but due to the cost and possible danger of poisoning are not practical for large areas.

Work reported from South Carolina(14) on controlling wild onions indicates that the most effective method is to go through the pasture when onions are about six inches tall and cut them off even with the ground. A few weeks later when the onions have made additional growth the process should be repeated. This method eradicated the onions for the season.

DISCUSSION OF RESULTS

In considering the results obtained in the pasture trials at the South Dakota Experiment Station one must keep in mind the conditions under which the plots were pastured.

The cows were not put on the pasture plots until the plants were from 6 to 10 inches high. When the pasture did not provide sufficient feed to meet the needs of the cows, except for the grain fed, the cows were taken off the pasture plots. The point is that if the plots had been pastured so long as there was anything on them for the cows to eat, as is done by the average dairyman, appreciably more feed would have been obtained from these plots. However from an experimental point of view it was felt that when it became necessary to supplement the pasture with roughages and grain the problem of determining what portion of the nutrients was derived from the pasture would be very difficult. Therefore the cows were removed from the plots when in our opinion the pasture plots were not adequate to provide roughage nutrients.

Grain was fed according to production allowing 1 pound of grain to 5 pounds of milk for Jerseys and Gurnseys and 1 pound of grain to 6 pounds of milk for Holsteins and Ayrshires. The grain mixture consisted of equal parts of yellow corn and oats, except during 1927 when a small amount of

oil meal was added to the grain mixture. Bran and cotton seed meal were added to the grain mixture in 1932 and 1934. Table 7 shows the kind and amount of grain fed on each pasture during the experimental period.

During several pasture seasons the cows were put back onto the plots when the grass attained sufficient growth to again provide adequate nutrients to supplement the grain fed.

During early spring a sufficient number of cows were put on the plots to keep them grazed down. Later in the summer when the pastures were short some of the cows were taken off. The plan was to have cows from the several breeds on each plot. Cows were chosen which were as nearly comparable in production, weight, and age as possible. In some instances the same cows were used for these trials for several years. This was particularly true of the older cows in the herd.

No effort was made to use particular cows for certain plots, or to use the same cows on the same or different plots the various pasture seasons. The plan was to distribute the cows each year according to breed, production and weight.

Table 10 shows the average weight of each group of cows in various plots for the ten pasture seasons.

Salt and bone meal were made available to the cows in the pasture plots. The cows were put on the plots shortly after the morning's milking and taken up the middle of the forenoon for watering. They were allowed to remain on the plots until 2:30 p.m. when they were stabled and fed grain.

The cows were put back on the plots after the evening milking and in most instances allowed to remain on the plots until 4 a.m. In other cases the cows were taken off at 9 p.m. and placed in a dry lot for the night.

Length of Pasture Season.—The dairyman is as much concerned with the length of time he can depend on pasturing a given type of pasture as he is with the total nutrients which the pasture will provide. It is necessary to have this information in planning feed for the dairy herd for the summer season.

In considering the data presented in Table 1 bear in mind what has previously been said concerning the methods of handling these plots. Consider the data in Table 1 in the light of the rainfall shown in Table 2.

TABLE 1.—Total Days on Pasture Plots

Year	Alfalfa Days	Sweet Clover Days	Sudan Grass Days	Range of Pasturing Dates Alfalfa	Sweet Clover	Sudan Grass
1927	98	98	*	June 3 - Sept. 8	June 3 - Sept. 8	*
1928	63	63	63	June 12 - Sept. 14	July 14 - Sept. 14	July 11 - Sept. 11
1929	89	88	63	June 12 - Sept. 8	June 13 - Sept. 8	July 7 - Sept. 8
1930	62	*	25	May 24 - June 24	*	July 1 - July 25
1931	42	52	*	June 16 - July 28	June 16 - Aug. 7	*
1932	*	109	89	*	May 15 - Sept. 1	June 24 - Sept. 20
1933	*	20	20	*	May 31 - June 19	July 8 - July 27
1934	57	48	20	May 16 - July 28	May 26 - July 28	July 4 - July 23
1935	80	70	60	May 21 - Aug. 26	June 5 - Aug. 26	July 1 - Aug. 30
1936	63-80	60	60-60	May 15 - Sept. 22	May 26 - July 9	June 24 - Sept. 22
1937	40	70	50	May 20 - June 29	May 30 - Aug. 18	July 1 - Sept. 9
Av.	67.4	67.8	51.0			

* No pasture data available.

Table 1 shows the total number of days on which data is available by years. The asterisks indicate the years when no pasture data were available, either because of failure of the stand, or as in the case of alfalfa plots in 1932 and 1933 not a sufficient number of cows negative to Bang's disease were available.

TABLE 2.—Rainfall

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total Year	Total* growing Season
1927	.14	.35	.83	4.04	4.29	1.46	4.88	.35	1.98	.49	.49	1.10	20.40	17.00
1928	.09	.30	.44	.96	.53	2.97	2.69	4.52	1.37	1.68	.78	.15	16.48	13.04
1929	.96	.45	.68	3.32	2.11	1.12	3.25	2.33	4.80	2.41	.04	.07	21.58	16.93
1930	.42	.40	.25	1.25	2.04	1.68	.27	1.50	3.38	1.84	2.01	.10	15.14	10.12
1931	.03	.04	.30	1.33	.68	2.42	1.62	3.24	2.00	1.11	1.89	1.07	15.73	12.40
1932	.54	.13	.27	1.34	2.23	3.07	2.34	4.07	2.07	.81	.32	.24	17.43	15.12
1933	.07	.18	1.08	.98	1.44	.67	1.42	2.10	3.82	.05	.09	.50	12.40	10.43
1934	.21	.05	.47	.14	1.49	4.77	3.56	.82	4.38	1.26	.38	.18	17.71	15.16
1935	.32	.16	1.47	3.47	2.11	2.75	1.66	4.19	.04	.23	.43	.62	17.45	14.22
1936	.53	1.16	.76	1.54	3.49	3.13	.20	3.86	1.34	.04	.30	.57	16.92	13.56
1937	.45	.26	2.03	3.19	1.70	2.39	1.16	2.28	.55	1.11	.31	.76	16.19	11.27

* April 1 to Oct. 1 Growing Pasture season.
1. Data on rainfall from Agronomy Department S.D.S.C.

During the pasture season of 1936 two plots of alfalfa and sudan grass respectively were pastured and the data are included as separate plots.

The date of pasturing includes the range of the pasture season and not the continuous pasture days. During several seasons the cows were taken off the plots until the pasture conditions changed sufficiently to warrant putting the cows back on the pasture plots again.

The average length of the pasture season for alfalfa and sweet clover are virtually the same over a 10 year period. The alfalfa came on somewhat earlier in the spring of the year, but did not in all years withstand the drought as well as the sweet clover. In the vicinity of Brookings, one can plan on alfalfa and sweet clover pastures by the middle of May, and in favorable seasons even earlier. With sufficient subsoil moisture, supplemented with timely seasonal rains these pastures should furnish abundant pasture until the latter part of September.

The Sudan grass is ready for pasturing the first part of July, in favorable seasons the last week in June. Sudan grass pasture will furish excellent feed up to heavy frosts, or to the latter part of September.

Palatability of the Three Pasture Grasses.—In ascertaining the palatability of feed for livestock personal opinion has a part. There is no definite measure except one's judgement on the manner in which cows eat the grasses. Our observations indicate the sudan grass ranks first in palatability with alfalfa second and sweet clover third. When the cows were turned onto the sweet clover plots they were observed to eat weeds and the other grasses before eating the sweet clover, but when once started they ate it readily. All the cows ate the sudan grass and showed every indication of enjoying it. In the case of the alfalfa the cows were observed to overlook the patches where the alfalfa grew rank and seemed to prefer the shorter plants. In one of the alfalfa plots the drainage tile came within several feet of the surface. The available moisture in this spot produced a heavier growth of alfalfa than in any other part of the pasture plot, however this portion of the alfalfa pasture was avoided by the cows until the balance of the plot was eaten down.

On several occasions it was necessary to clip the weeds in the pasture plots. In doing this the bar of the mower was raised high enough so that very little of the plants were destroyed. The weeds were raked and hauled off the plots.

Notes and Observations.—The plan of the project, contemplated a study of bloat, and other factors which might add information so as to better appraise the merits of the various cultivated pastures.

During the several pasture seasons some of the plants particularly

the sweet clover, bloomed, but usually the plants were grazed too close to permit them to bloom.

The pasture plants were handled as annuals. That is, seeded one year and not pastured until the following year. This routine has been followed regularly except in the case of one alfalfa plot which has been pastured for four successive pasture seasons.

For the first six pasture seasons no trouble was experienced with bloat. The first cases occurred on September 9, 1933, several days after heavy rain.

The cows were removed from the sweet clover and sudan grass pasture plots earlier in the season, because of drought. During the season 1933 the alfalfa plots were not pastured because of not having cows negative to Bangs disease.

On September 3 a heavy rain started the pasture plants growing. In a few days the alfalfa plot showed a good stand of alfalfa. The cows were turned on the plot after milking, and left on for the night. When the herdsman went to get them the next morning two Holsteins and one Ayrshire were dead. Several other cows indicated by their condition that they had probably been bloated but survived.

The alfalfa plants were growing rapidly and no doubt were very palatable. The cows had received grain, and dry roughage, before turning on the plot, so could not be said to be hungry but probably ate the young plants greedily.

The past two seasons several cows were observed to bloat during May and June. The bloating usually was observed early in the evening. (When the cows were taken off the pasture no further difficulty resulted.) The cows were watched rather closely for the first two or three hours after turning on the pasture. Many of the so called remedies were tried, such as keeping salt, lime, water, charcoal, available to the cows at all times and pasturing the cows continuously, but no noticeable effect could be discerned. The cows received grain according to production in addition to the pasture. Inasmuch as the cows were not placed on the pastures, unless they provided good grazing, the cows were never unduly empty or hungry when turned on the plots.

During the spring of 1938 the rainfall for the month of May was above normal. Considerable trouble with bloat was experienced with the cows on sweet clover pasture. No alfalfa pasture was available therefore no comparative results can be given.

A number of samples of gas were obtained from cows which were more or less bloated. These samples were obtained by means of inserting a rubber tube into the gullet of the cow, and the gas was caught in a rubber-gas-bag.

One cow bloated to the stage where it became necessary to use the trochar. Several bagfuls of gas were secured from this animal. The cow died, and samples of the rumen contents were taken.

Several samples of gas were produced in the laboratory from sweet clover and alfalfa plants cut during the middle of the day. The gas generated in the laboratory from sweet clover and alfalfa plants, gathered during the early part of the afternoon, (when the cows did not bloat while pasturing on sweet clover) showed 65 per cent carbon dioxide and 35 per cent hydrogen, but no methane.

The samples of gas which were secured from the rumen of the cows showed from 60 to 70 per cent carbon dioxide and 12 to 14 per cent methane, with small percentages of oxygen, nitrogen, and other inert gasses.

The sample of gas from the cow which died from bloat, which was less contaminated with air than samples obtained through the gullet, analyzed 72 per cent of carbon dioxide, 15 per cent methane, and 13 per cent of inert gases.

Another condition which is significant in appraising these cultivated pastures, is their effect on the flavor of the milk. When the cows were taken off the pastures two hours before milking no deleterious effects on flavor could be noted. The milk was used as market milk, and no complaints were made by any of the consumers.

Because of the variation in the stand of the pasture, the length of the pasture season, and the production of the cows which were placed on any particular plot, the total pounds of milk produced on the various plots varied widely, despite the fact that an effort was made to have factors as uniform as practicable. It is felt however that when an average of the ten pasture seasons is considered that the yearly variations are pretty well ironed out.

The cows on the sweet clover plots were frequently observed to be very "loose". This condition did not however seem to affect the milk flow.

Milk and Butterfat Produced Per Acre.—The dairy farmer is interested in the greatest return per unit of his land. If he can utilize his available acreage so that the returns per acre are increased he is following recommended farm practices.

It is to be expected that the returns will vary from year to year depending on the available pasture as well as the production of the cows. However a 10 year pasture period tends to level out these annual variations.

TABLE 3.—Milk and Butterfat per Acre for Pasture Season

Year	Alfalfa		Sweet Clover		Sudan Grass	
	Milk lbs.	Fat lbs.	Milk lbs.	Fat lbs.	Milk lbs.	Fat lbs.
1927	3941.9	145.33	4939.7	179.02	*	*
1928	1426.8	60.83	1786.9	74.86	2911.4	126.37
1929	3177.1	146.62	3847.8	160.83	2508.1	114.69
1930	3422.0	142.49	*	*	1408.2	56.66
1931	1775.0	62.40	2229.0	86.40	*	*
1932	*	*	7025.4	260.90	3913.7	133.80
1933	*	*	3523.9	133.77	1234.8	44.85
1934	3460.7	135.29	3161.3	117.32	1831.5	72.22
1935	5975.0	238.61	4281.6	167.35	3060.2	113.77
1936	2898.5	120.54		167.35	3847.3	146.62
	4529.2	193.07	3136.3	130.44	4252.2	174.93
1937	2471.5	110.23	2753.2	155.87	2698.2	115.58
Av.	3307.99	135.54	3668.53	146.68	2766.58	109.95

* No pasture available.

The data in Table 3 show an average production for the ten pasture seasons of 135.54, 146.68, 109.95 pounds of fat and 3307.99, 3668.53, 2766.58 pounds of milk per acre respectively for the three cultivated pastures.

These data indicate what can be realized from cultivated pastures when grazed by good milk cows. Under more favorable conditions of rainfall the length of the pasture season as well as the carrying capacity would undoubtedly be materially increased.

Carrying Capacity.—The number of cows which can be pastured on an acre of cultivated pasture is no less important than the gross returns from the pastures. It is apparent that the size of the cow and her milk production are important factors affecting the returns from each plot. Heavy producing cows show better returns than mediocre or low produc-

ers. An attempt was made to adjust the production and breeds so that each pasture plot had cows of about the same production and breeds. An entirely equitable distribution was not always feasible because of the limited number of cows available to choose from.

To obviate this difference as far as possible, the carrying capacity is adjusted to standard conditions. That is, the carrying capacity is adjusted to a 1200 pound cow producing 20 pounds of 4 per cent milk per day. This method will permit of a direct comparison of the carrying capacity of the several cultivated pastures.

In computing the requirements for a standard cow 16 pounds of total digestible nutrients per standard cow per day is used. This is the amount suggested in Bulletin 295, Washington State College Experiment Station.

TABLE 4.—Data Converted to Standard Cow[1]

Year	Alfalfa			Sweet Clover			Sudan Grass		
	Net T.D.N. per acre	Cow Days per acre	Cows per acre	Net T.D.N. per acre	Cow Days per acre	Cows per acre	Net T.D.N. per acre	Cow Days per acre	Cows per acre
1927	1895.46	118.47	1.21	2469.51	154.34	1.57			
1928	1011.70	63.23	1.00	1275.05	79.69	1.26	1883.19	117.70	1.87
1929	2473.51	154.59	1.74	2485.60	155.35	1.77	1934.85	120.93	1.92
1930	2436.16	152.26	2.46	*	*	*	903.06	56.44	2.26
1931	948.26	59.27	1.41	1529.19	95.57	1.84	*	*	*
1932	*	*	*	3575.09	223.44	2.05	2203.36	137.71	1.55
1933	*	*	*	1407.09	87.94	4.40	568.44	35.53	1.78
1934	1953.40	122.09	2.14	1504.76	94.05	1.96	1062.11	66.38	3.32
1935	2890.42	180.65	2.26	2015.02	125.94	1.80	1684.16	105.26	1.75
1936	2474.01	154.63	2.45	1594.84	99.68	1.66	2010.56	125.66	2.09
1936	1889.11	118.07	1.48				2013.27	125.83	2.10
1937	1200.37	75.02	1.88	1790.41	111.90	1.60	1457.75	91.11	1.82
Total	19172.40	1198.28		19646.56	1227.90		15720.75	982.55	
Av.	1917.24	119.83	1.78	1964.66	122.79	1.81	1572.08	98.26	1.93

1. Standard cow—1200 pound producing 20 pounds of 4 per cent milk.
* No pasture available.

Table 4 shows the data for the ten pasture seasons converted to standard cows. The carrying capacity varies from a little over one standard cow per acre to more than five and a half standard cows in case of sweet clover in 1933. During this particular pasture season 14 heavy producing cows were pastured on the 3.2 acre plot for 20 days. Hence the data may be misleading on the carrying capacity of sweet clover pasture. The standard cow days (standard cows times days on pasture) is perhaps a more accurate measure of the grazing value of the pasture. When the three pastures are compared on this basis alfalfa and sweet clover show somewhat greater value than sudan pasture yet sudan shows a higher carrying capacity.

When these data are studied in connection with the table on moisture, it is apparent that sudan is more drought resistant than either of the legumes. With adequate moisture the data would undoubtedly be more favorable to the legume pasture both in cow days and carrying capacity.

Comparative Value of Pastures.—Pastures can be compared on the basis of the net nutrients as expressed in the milk and maintenance of the cows pastured. The nutritive value so expressed obviously would be greatly affected by the production and size of the cows on the plots. However the average of the ten pasture seasons should tend to level out any discrepancies due to the difference in producing ability of the cows.

Table 5 indicates the nutrients obtained each year over the 10 years, and the average for the 10-year period. In order that the nutrients pro-

TABLE 5.—Pasture Value Expressed in Terms of Crops

Year	Alfalfa Pasture Net TDN Lbs.	Wheat TDN50.16 Bushels	Oats TDN 22.88 Bushels	Corn TDN 45.74 Bushels	Barley TDN 37.77 Bushels
1927	1895.46	37.78	82.84	41.99	50.18
1928	1011.70	20.16	44.21	22.41	26.78
1929	2473.51	49.31	98.10	54.80	65.48
1930	2436.16	48.56	96.48	53.97	64.49
1931	948.26	18.90	41.44	21.01	25.10
1932	*				
1933	*				
1934	1953.40	38.94	85.37	43.26	51.71
1935	2890.42	57.62	126.33	63.19	76.53
1936	2474.01	49.32	98.12	54.81	65.49
1936	1889.11	37.65	82.56	41.85	50.01
1937	1200.37	23.93	52.40	26.59	31.78
Av.	1917.24	38.22	83.80	41.92	50.76
	Sweet Clover Pasture	**Wheat Bushels**	**Oats Bushels**	**Corn Bushels**	**Barley Bushels**
1927	2469.51	49.23	107.93	54.71	65.37
1928	1275.05	25.42	55.73	28.25	33.75
1929	2485.60	49.55	108.63	55.06	65.79
1930	*				
1931	1529.19	30.48	66.82	33.87	40.47
1932	3575.09	71.27	156.25	78.16	94.65
1933	1407.09	28.05	61.50	30.76	37.25
1934	1504.76	30.00	65.77	33.34	39.83
1935	2015.02	40.17	88.07	44.05	53.35
1936	1594.84	31.80	69.72	35.34	42.22
1937	1790.41	35.69	78.24	39.66	47.39
Av.	1964.66	39.17	85.87	42.95	52.02
	Sudan Pasture	**Wheat Bushels**	**Oats Bushels**	**Corn Bushels**	**Barley Bushels**
1928	1883.19	37.54	82.31	41.72	49.85
1929	1934.85	38.57	84.56	42.86	51.21
1930	903.06	18.00	39.46	20.00	23.90
1931	*				
1932	2202.36	43.91	96.26	48.15	58.31
1933	568.44	11.33	24.84	12.43	15.05
1934	1062.11	21.17	46.41	23.53	28.11
1935	1684.16	33.58	73.61	36.82	44.59
1936	2010.56	40.08	87.87	44.54	53.22
1936	2013.27	40.14	88.00	44.61	53.30
1937	1457.75	29.06	63.71	32.29	38.58
Av.	1571.98	31.34	68.71	34.37	41.62

* No pasture available.

duced on each pasture may be more readily comprehended, the nutrients produced on each type of pasture are expressed in bushels of wheat, oats, corn and barley, crops which are grown quite generally in South Dakota.

The conversions were made by dividing the total digestible nutrients in one bushel of these crops into the total digestible nutrients in the milk produced and for maintenance of the cows, exclusive of the total digestible nutrients in the grain fed. For example in the case of the alfalfa pasture in 1927, 1895.46 pounds of total digestible nutrients were produced from one acre. Sixty pounds, or one bushel of wheat, contain 50.16 pounds of total digestible nutrients, therefore 1895.46 divided by 50.16 equals 37.78 or the number of bushels of wheat equivalent in total digestible nutrient value to the total digestible nutrient value of milk and maintenance per acre.

A cursory review of the data in Table 5 emphasizes the importance of cultivated pastures. Many farmers feel they cannot afford to pasture good tillable land, yet it is doubtful whether any farmer, even in the more favored farming sections of the United States could show as high an average yield of these crops as is shown in this table.

The yield of these cereal crops in the vicinity of Brookings, where

TABLE 6.—Amount and Kind (Per Acre) of Grain Fed (lbs.)

Kind of grain fed	1927			1928			1929			1930			1931		
	Alfalfa	Sw. Cl.	Sudan	Alfalfa	Sw. Cl.	Sudan	Alfalfa	Sw. Cl.	Sudan	Alfalfa	Sw. Cl.	Sudan	Alfalfa	Sw. Cl.	Sudan
Corn	275.4	345.6		47.0	54.5	152.0	247.5	284.5	167.0	324.0		129.0	130.5	157.5	
Oats	275.4	345.6		47.0	54.5	152.0	247.5	284.5	167.0	324.0		129.0	130.5	157.5	
Oil Meal	45.8	58.8													
Total	596.6	750.0		94.0	109.0	304.0	495.0	569.0	334.0	648.0		258.0	261.0	315.0	

Kind of grain fed	1932			1933			1934			1935			*		1936			1937		
	Alfalfa	Sw. Cl.	Sudan	Al-falfa	Sw. Cl.	Sudan	Alfalfa	Sw. Cl.	Sudan	Alfalfa	Sw. Cl	Sudan	(5) Al-falfa	(2) Al-falfa	Sw. Cl.	(1) Su-dan	(3) Su-dan	Alfalfa	Sw. Cl.	Sudan
Corn		520.3	224.7	384.1	182.0	336.9	376.9	93.3	628.2	459.9	303.9	163.4	130.5	227.7				245.3	311.7	276.6
Oats		653.2	370.8	384.1	182.0	336.9	376.9	93.3	542.2	380.2	221.1	440.0	276.9	302.5	378.1	421.9		245.3	311.7	276.6
Barley		133.0	146.1						86.0	79.7	82.8	276.6	146.4	78.0	378.1	421.9				
Bran		33.25	48.7			49.6														
C. Seed Meal		163.6	89.4			60.0														
Beet Pulp						60.0														
Total		1503.35	879.7	768.2	364.0	843.4	753.8	186.6	12,56.4	919.8	607.8	880.0	553.8	608.2	756.2	843.8		490.6	623.4	532.2

* Refers to number of plot.

TABLE 7.—T.D.N. (Per Acre) From Grain Fed to Cows on Pasture[1]

Kind of grain fed	1927			1928			1929			1930			1931		
	Alfalfa	Sw. Cl.	Sudan	Alfalfa	Sw. Cl.	Sudan	Alfalfa	Sw. Cl.	Sudan	Alfalfa	Sw. Cl.	Sudan	Alfalfa	Sw. Cl.	Sudan
Corn	225.00	282.36		38.40	44.53	124.18	202.21	232.44	136.44	264.71		105.39	106.62	128.68	
Oats	193.99	243.44		33.11	38.39	107.07	174.34	200.40	117.63	228.23		90.87	91.92	91.92	
Oil Meal	35.86	46.04													
Total	454.85	571.84		71.51	82.92	231.25	376.55	432.84	254.07	492.94		196.26	198.54	239.62	

Kind of grain fed	1932			1933			1934			1935			(2)	(5)	1936	(1)	(3)	1937		
	Alf.	Sw.Cl.	Sudan	Alf.	Sw.Cl.	Sudan	Alf.	Sw. Cl.	Sudan	Alf.	Sw. Cl.	Sudan	Alf.	Alf.	Sw. Cl.	Sudan	Sudan	Alf.	Sw. Cl.	Sudan
Corn	425.1	183.6		313.8	148.7	275.2	307.9	76.2	513.2	375.7	248.3	133.5	106.6	186.0			200.0	254.7	226.0	
Oats	460.1	261.2		270.6	128.2	237.3	265.5	65.7	381.9	267.8	155.7	309.9	195.0	213.0	266.4	297.2	172.8	219.6	194.8	
Barley	105.6	116.0							68.3	63.3	65.7	219.6	116.2	61.9	300.2	335.0				
Bran	19.9	29.1				29.6														
C .Seed Meal	131.2	71.7				48.1														
Beet Pulp						43.0														
Total	1141.9	661.6		584.4	276.9	633.2	573.4	141.9	963.4	706.8	469.7	663.0	417.8	461.0	566.6	622.2	373.2	474.3	420.8	

1. Factors used to convert grain to T.D.N. from S. D. Bul. 231.
   Corn 81.70
   Oats 70.44
   Barley 79.40

these pasture trials were conducted is only a fraction of that expressed in Table 5. Several of the ten years have been drought years, and the cereal crops have been partial or complete failures.

It is also significant that the legume pastures are factors in improving the fertility and tilth of the soil whereas ceral crops deplete the fertility and make possible the washing and blowing of soil areas.

TABLE 8.—Milk and Butterfat Produced Per Acre Corrected to 4% Milk (Gaines Formula) (O.4M 15F where M is milk, F is fat)

	Alfalfa				Sweet Clover				Sudan Grass			
	Actual Production			Corrected to 4% milk	Actual Production			Corrected to 4% milk	Actual Production			Corrected to 4% milk
	Milk	Fat	%	Milk	Milk	Fat	%	Milk	Milk	Fat	%	Milk
1927	3941.9	145.33	3.69	3764.5	4939.7	179.02	3.62	4643.3	*	*		
1928	1426.8	60.83	4.26	1481.0	1786.9	74.86	4.19	1840.5	2911.4	126.37	4.34	3065.7
1929	3177.1	146.62	4.61	3463.0	3847.8	160.83	4.18	3963.2	2508.1	114.69	4.57	2716.3
1930	3422.0	142.49	4.16	3500.7	*	*			1408.2	56.66	4.02	1408.2
1931	1775.0	62.40	3.52	1641.9	2229.0	86.40	3.88	2195.6	*	*		
1932	*	*			7025.4	260.9	3.71	6709.3	3913.7	133.8	3.42	3561.5
1933	*	*			3523.9	133.77	3.80	3418.2	1234.8	44.85	3.63	1170.6
1934	3460.7	135.29	3.91	3408.8	3161.3	117.32	3.71	2064.1	1831.5	72.22	3.94	1818.7
1935	5975.0 (2)	238.61	3.99	5975.1	4281.6	167.37	3.91	4217.4 (1)	3060.2	113.77	3.72	2922.6
1936	2898.5 (5)	120.54	4.16	2965.2	3136.3	130.44	4.16	3208.5 (3)	3847.3	146.62	3.81	3731.9
	4529.2 (5)	193.07 (5)	4.26	4701.0	(4)	(4)			4252.2	174.93	4.11	4316.1
1937	2471.5	110.23	4.46	2639.6	2753.2	155.87	5.66	3436.1	2698.2	115.58	4.28	2819.7
Av.	3307.99	135.54		3356.29	3668.53	146.68		3667.61	2766.58	109.95		2755.88

* No available pasture.

TABLE 9.—T.D.N. Requirements for Maintenance of Cows on Pasture

Year	Alfalfa Average Weight lbs.	Alfalfa T.D.N. lbs.	Sweet Clover Average Weight lbs.	Sweet Clover T.D.N. lbs.	Sudan Grass Average Weight lbs.	Sudan Grass T.D.N. lbs.
1927	1206	9.510	1246	9.906	*	
1928	1127	8.916	1173	9.312	1174	9.312
1929	1067	8.519	1146	9.114	1146	9.114
1930	1213	9.708			1246	9.906
1931	1077	8.519	1165	9.312	*	
1932	*		1101	8.717	1194	9.510
1933	*		1196	9.510	1300	10.302
1934	1148	9.114	1095	8.717	967	7.727
1935	1051	8.321	1136	8.916	1212	9.510
1936	1147 (5)	9.114	973	7.727	1088 (1)	8.717
	985 (2)	7.727			1059 (3)	8.321
1937	902	7.132	900	7.132	978	7.727
Av.	1092.3	8.658	1113.1	8.836	1136.4	9.014

* No pasture available.

TABLE 10.—T.D.N. Produced Per Acre

Year	Alfalfa T.D.N. from Milk lbs.	Alfalfa T.D.N. for Maintenance lbs.	Sweet Clover T.D.N. from Milk lbs.	Sweet Clover T.D.N. for Maintenance lbs.	Sudan Grass T.D.N. from Milk lbs.	Sudan Grass T.D.N. for Maintenance lbs.
1927	1273.23	1166.88	1575.76	1581.99	*	
1928	506.51	753.40	627.20	957.27	1045.19	1347.45
1929	1191.41	1658.65	1346.73	1571.71	933.01	1255.91
1930	1194.28	1734.82	*		480.19	619.13
1931	555.58	591.22	744.99	1024.32	*	
1932	*		2276.23	2440.76	1205.42	1658.54
1933	*		1159.36	832.13	395.14	450.20
1934	1159.35	1427.25	1024.27	1053.89	617.22	586.79
1935	2031.52	1822.30	1434.35	1287.47	994.59	1159.27
1936 (2)	1011.59	1880.22	1094.60	961.24	1269.61	1307.55
(5)	1607.87	944.24			1475.54	1169.93
1937	904.59	668.98	1194.91	1069.80	960.58	917.97
Total	11435.93	12647.96	12477.90	12780.58	9574.86	10472.74

* No pasture available.

TABLE 11.—Summary of the Ten Pasture Seasons

	Alfalfa Pasture (per acre)			Sweet Clover Pasture (per acre)			Sudan Grass Pasture (per acre)		
	Total T.D.N.	T.D.N. from Grain	Net T.D.N. from Pasture	Total T.D.N.	T.D.N. from Grain	Net T.D.N. from Pasture	Total T.D.N.	T.D.N. from Grain	Net T.D.N. from Pasture
1934	2440.11	544.65	1895.46	3157.75	688.24	2469.51	*		
1935	1259.91	248.21	1011.70	1584.47	309.42	1275.05	2392.64	509.45	1883.19
	2850.06	376.55	2473.51	2918.44	432.84	2485.60	2188.92	254.07	1934.85
1936	2929.10	492.94	2436.16	*			1099.32	196.26	903.06
	1146.80	198.54	948.26	1768.81	239.62	1529.19	*		
	*			4716.99	1141.90	3575.09	2863.96	661.60	2202.36
1937	*			1991.49	584.40	1407.09	845.34	276.90	568.44
Total	2586.60	633.20	1953.40	2078.16	573.40	1504.76	1204.01	141.90	1062.11
1927	3853.82	963.40	2890.42	2721.82	706.80	2015.02	2153.86	469.70	1684.16
1928	(2)						(1)		
1929	2891.81	417.80	2474.01	2055.84	461.00	1594.84	2577.16	566.60	2010.56
1930	(5)						(3)		
1931	2552.11	663.00	1889.11				2645.47	632.20	2013.27
1932	1573.57	373.20	1200.37	2264.71	474.30	1790.41	1878.55	420.8	1457.75
1933	24083.89	4911.49	19172.40	25258.48	5611.92	19646.56	19849.23	4129.48	15719.75
Standard Cow Days			119.83			122.79			98.26
Average Cows Per Acre			1.78			1.81			1.93

* No pasture available.

Summary and Conclusions

1. A series of cultivated pasture trials were started in 1927 for the purpose of determining the adaptibility of these crops for pasturing under South Dakota conditions.

2. The three plots included alfalfa, sweet clover, and sudan. Later three more plots of permanent pasture mixtures were added, however no data is available because of lack of sufficient moisture.

3. One group of plots was planted each year while the other was pastured. Each plot after the first year contained three and two tenths acres (3.2).

4. About seven cows were placed on the plots when the plants were from 6 to 10 inches high. When the pasture growth was especially good a larger number of cows were turned on until it was eaten down.

5. The cows chosen for each plot were representatives of the three major breeds and as similar in production and size as it was possible to have them,

6. The cows were weighed at 10-day intervals, and if the pasture was not adequate, one or more cows were taken off. If the converse were true, one or more cows were added.

7. The cows were fed a grain mixture of equal parts of corn, and oats, according to their milk production. Bone meal and salt were kept before them in the pasture plots.

8. Little trouble was experienced with bloat. During several seasons some trouble was experienced in the early part of the pasture season and it seemed to be more prevelant with some cows than others, and most troublesome during the early part of the evening. Three cows were found dead several days following a heavy rain the fore part of September.

9. Many recommended remedies such as feeding lime, charcoal, not turning on pasture hungry, watering often, leaving on pasture continuously were tried, with no definite results.

10. When the legumes are growing rapidly there seems to be more danger from bloat than under any other conditions. Rapid growth occurs during adequate moisture and high temperature conditions.

11. Sudan pasture was the most palatable followed by alfalfa and sweet clover. The cows were observed to eat weeds and other grasses in the sweet clover plots before eating the sweet clover plants. When the cows had become accustumed to the sweet clover plants they ate them readily.

12. None of the pasture plants had any deleterious effect on the flavor of the milk when the cows were handled under conditions of these trials, that is, taken off the pasture from two and a half to three hours before milking.

13. The cows lost weight on the sweet clover plots, and seemed somewhat looser, than on the other plots, although the latter conditions varied somewhat with the season.

14. The results expressed in net nutrients per acre were highest for the sweet clover plots and lowest for sudan plots. The sweet clover plots also showed a higher carrying capacity per acre than alfalfa but somewhat less than the sudan plots.

15. The average length of the pasture season was virtually the same for alfalfa and sweet clover, being 67.4 and 67.8 days respectively as a 10 year average. The sudan plots averaged 51 days for the 10 years. Lack of moisture was the cause of relatively short pasture season on all plots, but probably affected the legumes more than the sudan.

16. The plots ranked in this order in the amount of milk and butterfat returned per acre. Sweet clover 3668.53 pounds of milk, 146.68 pounds of fat; alfalfa 3307.99 pounds of milk, 135.54 pounds of fat; and sudan 2766.58 pounds of milk and 109.95 pounds of fat.

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