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AGRICULTURAL INVESTIGATIONS AT THE HUNTLEY (MONT.) FIELD STATION, 1927-30.
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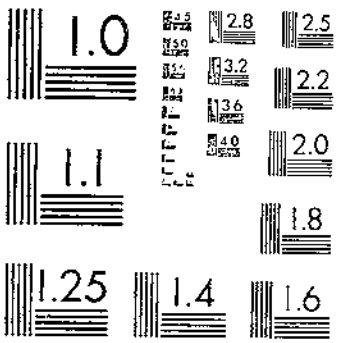

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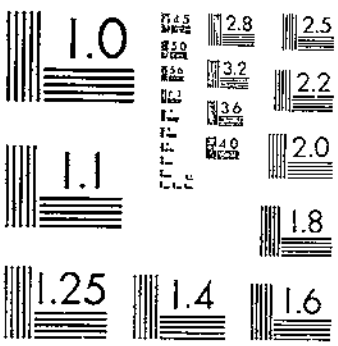

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

TECHNICAL BULLETIN No. 353 MAY 1933

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

AGRICULTURAL INVESTIGATIONS AT THE HUNTLEY (MONT.) FIELD STATION, 1927–1930

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In Cooperation with the Montana Agricultural Experiment Station

CONTENTS

INTRODUCTION

The work of the Huntley field station, which is located on the Huntley reclamation project in the Yellowstone Valley of southern Montana, deals with investigations in the production and utilization of crops on both irrigated and dry land as well as experiments with dairy cattle, hogs, and sheep. The station is maintained cooperatively by the Division of Western Irrigation Agriculture of the Bureau of Plant Industry, United States Department of Agriculture, and the Montana Agricultural Experiment Station, and facilities are provided for cooperative work by various other divisions of the Department of Agriculture as well as the various departments of the Montana station.

This report presents the results of the investigational work during the four years 1927 to 1930, inclusive, as well as a summary of the more important experiments that have been under way over longer periods. Figure 1 illustrates the location of the fields comprising the station tract and the cropping system in effect in 1930.

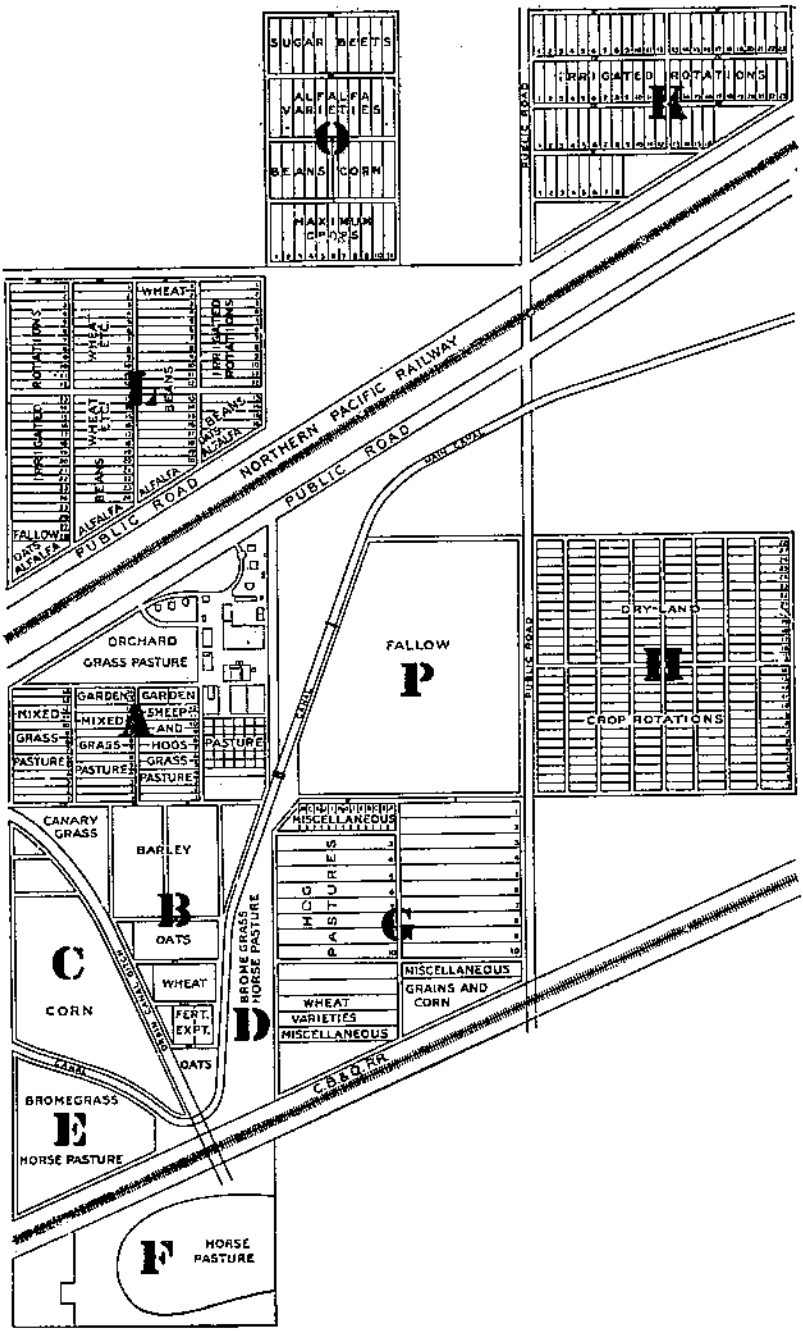

FIGURE 1.—Arrangement of fields and location of experiments at the Huntley field station in 1930

CLIMATIC CONDITIONS

Weather conditions were particularly favorable during 1927, when the total rainfall was 21.39 inches as compared with an average of 14.27 inches over the 20-year period 1911 to 1930, inclusive, during which climatic measurements have been recorded at this station. The rainfall during each of the three years 1928 to 1930, inclusive, was below normal and amounted to 12.93, 11.80, and 12.28 inches, respectively. Yields of dry-land crops were low during these years, and irrigated crops required much more than the usual amount of water. Precipitation during the spring months was particularly low, and it was necessary to irrigate to provide moisture for seed germination for most crops. The frost-free period during the years 1928 to 1930 was also shorter than the average of 126 days. The frost-free period in 1928 was 112 days, in 1929 it was 103 days, and in 1930 it was only 89 days. In spite of the low rainfall and the short period free from frost in 1930, favorable crop yields under irrigation were obtained, and yields of sugar beets were higher than in any other year in the history of the Huntley project. Weather conditions were favorable for the harvest of sugar beets and other late crops during the entire 4-year period. There was no serious injury from severe storms or hail.

Table 1 gives a summary of the climatological observations during the 20-year period 1911 to 1930, inclusive.

TABLE 1.—*Summary of climatological observations at the Huntley field station during the 20-year period 1911–1930*

PRECIPITATION (INCHES)

Item	January	February	March	April	May	June	July	August	September	October	November	December	Total
Average, 1910–1930	0.79	0.42	0.80	1.28	2.13	2.28	1.31	0.92	1.44	1.16	0.86	0.88	14.27
1927	1.06	.15	.12	3.38	5.09	2.21	.04	2.85	1.14	.31	1.94	2.20	21.39
1928	2.75	.06	.24	1.07	.84	1.45	1.66	1.01	.36	1.77	.58	1.14	12.93
1929	1.21	.97	1.68	.76	.50	2.17	.49	.17	1.41	.84	.58	1.02	11.80
1930	.87	.39	1.34	1.86	.61	1.25	1.05	1.15	1.23	2.19	.34	[1] T	12.28

EVAPORATION (INCHES)

Average, 1911–1930	----	----	----	3.458	4.925	6.105	7.484	6.762	4.297	----	----	----	33.031
1927	----	----	----	3.267	3.903	4.838	6.688	5.447	3.577	----	----	----	27.780
1928	----	----	----	3.654	6.395	5.452	6.883	6.425	4.650	----	----	----	33.459
1929	----	----	----	3.756	4.951	6.379	8.069	7.341	3.921	----	----	----	34.417
1930	----	----	----	4.444	6.193	7.706	8.206	6.615	4.134	----	----	----	37.208

DAILY WIND VELOCITY (MILES PER HOUR)

Highest:													
1911–1930	22.2	14.1	27.8	17.8	17.5	11.0	27.5	7.9	10.5	29.4	25.0	26.6	----
1927	8.2	8.9	8.6	6.4	9.4	6.2	3.6	3.3	6.5	6.3	6.3	8.5	----
1928	11.2	9.5	8.8	7.2	13.7	5.4	5.3	7.7	7.8	9.3	7.9	8.6	----
1929	9.0	10.4	11.3	10.8	9.4	9.4	4.9	5.2	6.8	6.1	10.1	10.5	----
1930	13.2	8.8	8.9	9.0	12.2	11.0	6.5	6.6	6.2	6.6	14.2	10.1	----
Lowest:													
1911–1930	.1	.2	.1	.6	.2	.1	.1	.3	.1	.1	.1	.1	----
1927	.0	.0	.3	.8	1.2	.1	.4	.5	1.0	.3	.5	.1	----
1928	.1	1.1	2.1	.8	.4	1.6	.2	1.0	1.2	.9	.3	.8	----
1929	.7	1.2	1.1	2.0	1.7	.2	.9	1.0	.6	.5	.9	.1	----
1930	.5	.4	.3	1.9	.9	1.8	1.1	.3	.6	.2	.9	1.0	----
Mean:													
1911–1930	4.9	4.4	4.5	5.0	4.6	3.5	3.0	3.0	3.3	3.5	3.9	4.6	----
1927	3.8	3.5	4.2	3.8	3.8	1.8	1.7	1.7	2.1	2.2	2.9	3.2	----
1928	4.0	4.4	4.6	4.5	3.6	3.4	3.0	2.8	3.1	3.4	3.5	4.6	----
1929	4.3	4.6	4.6	4.5	4.0	3.3	2.5	2.9	2.8	2.8	4.6	3.9	----
1930	4.4	4.1	4.0	4.9	4.9	4.3	3.1	2.8	2.7	2.3	4.0	4.7	----

[1] T=trace.

TABLE 1.—*Summary of climatological observations at the Huntley field station during the 20-year period 1911–1930*—Continued

TEMPERATURE (° F.)

Item	January	February	March	April	May	June	July	August	September	October	November	December	Total
Absolute maximum:													
1911–1930	65	70	80	88	99	107	105	103	99	91	75	67	------
1927	57	61	72	84	85	96	100	99	96	84	62	51	------
1928	52	52	80	85	93	87	97	99	93	84	68	61	------
1929	44	49	72	77	89	97	100	99	96	80	60	52	------
1930	52	70	64	85	88	97	105	98	99	72	72	60	------
Absolute minimum:													
1911–1930	−40	−38	−37	4	17	31	38	29	16	−15	−28	−42	------
1927	−30	−10	7	19	26	37	40	40	20	18	−2	−42	------
1928	−33	−8	17	11	27	34	45	37	25	13	9	−17	------
1929	−40	−37	10	17	17	34	38	45	25	16	−11	−26	------
1930	−35	2	−8	19	30	31	46	29	20	14	−12	6	------
Mean:													
1911–1930	18	24	33	45	54	64	71	69	57	45	33	22	------
1927	19	25	36	43	50	62	68	66	56	49	28	9	------
1928	21	26	40	43	61	60	70	66	57	44	35	25	------
1929	6	11	37	43	52	62	72	73	54	49	31	21	------
1930	6	35	32	53	55	64	74	72	59	41	34	33	------

KILLING FROSTS

Year	Last in spring		First in autumn		Frost-free period
	Date	Minimum temperature	Date	Minimum temperature	
		° F.		° F.	Days
1911	May 26	32	Sept. 18	28	115
1912	May 12	28	Sept. 15	31	126
1913	May 5	31	Sept. 19	29	137
1914	May 12	32	Oct. 6	31	147
1915	May 21	32	Sept. 19	32	121
1916	May 16	30	Sept. 13	31	120
1917	May 31	31	Sept. 28	32	120
1918	May 21	32	Oct. 7	28	139
1919	May 7	29	Sept. 27	32	143
1920	June 3	32	Sept. 24	32	113
1921	May 14	32	Sept. 9	32	118
1922	May 5	31	Sept. 28	29	146
1923	May 15	28	Oct. 11	30	149
1924	May 26	27	Sept. 14	32	111
1925	May 15	29	Sept. 30	32	138
1926	Apr. 26	31	Sept. 18	28	145
1927	May 18	32	Sept. 19	28	124
1928	May 31	31	Sept. 20	31	112
1929	May 27	30	Sept. 7	25	103
1930	June 3	31	Aug. 31	29	89
Average	May 18	------	Sept. 21	------	126

AGRICULTURAL CONDITIONS ON THE HUNTLEY RECLAMATION PROJECT

CROPS

The total cropped area of the Huntley reclamation project has increased during the period covered by this report and in 1930 amounted to 23,487 acres, according to the annual crop census furnished by the Bureau of Reclamation of the United States Department of the Interior. During the 10 years previous to 1927 the cropped area remained fairly constant and averaged slightly less than 20,000 acres.

The total irrigable area of farms reported in 1930 amounted to 26,639 acres, the difference between this figure and that for the cropped area representing land occupied by farmsteads, roads, and ditches. The total amount of land that can be irrigated by the Huntley Canal is 32,500 acres. That part of the project not represented in the irrigable area includes heavy, salty lands that are slow of reclamation and are classed as temporarily unproductive. The increase in the cropped area in recent years indicates that some of these marginal lands are slowly coming into production.

In order to show the general trend of crop acreages during the history of the project, Table 2 has been prepared. This table gives the acreage of each of the principal crops each year during the 18-year period 1913 to 1930, inclusive.

TABLE 2.—*Acreage of principal crops and total acreage of all crops grown on the Huntley reclamation project, 1913–1930*

[From reports of the Bureau of Reclamation]

Year	All crops	Alfalfa	Sugar beets	Beans	Barley	Corn	Oats	Summer pasture	Potatoes	Wheat
1913	15,798	4,848	4,475	.....	191	326	3,942	.....	99	1,177
1914	17,008	6,038	4,374	.....	383	497	3,226	.....	120	1,863
1915	18,203	5,287	5,402	.....	415	509	2,514	1,478	80	2,869
1916	18,531	5,422	5,264	.....	298	174	2,628	1,393	54	2,624
1917	19,104	6,002	3,360	.....	109	186	2,420	1,461	164	4,330
1918	19,265	6,776	1,963	.....	75	203	2,006	1,091	73	6,306
1919	19,310	7,045	1,136	.....	267	179	1,977	1,389	40	6,518
1920	20,021	7,468	2,330	.....	324	392	1,764	2,074	78	5,098
1921	18,782	5,538	3,178	.....	247	375	1,630	1,479	185	5,469
1922	19,523	6,167	3,106	11	223	425	1,434	1,670	149	5,793
1923	18,776	5,463	4,630	120	264	1,319	1,118	2,042	68	3,075
1924	19,768	5,724	5,929	540	222	956	912	2,335	21	2,212
1925	19,309	5,578	4,456	1,279	553	765	1,262	[1] 449 [2] 673	26	3,701
1926	19,789	5,746	4,767	1,075	570	369	997	2,011	39	3,858
1927	20,437	5,274	4,587	1,045	1,397	433	1,014	[1] 1,217 [2] 905	75	3,959
1928	22,737	5,155	2,085	2,777	1,870	235	834	[1] 1,330 [2] 345	29	5,324
1929	23,483	5,411	4,297	4,074	2,332	362	781	[1] 1,842 [2] 1,304	14	2,552
1930	23,487	5,187	4,988	3,667	2,199	216	772	[1] 1,248 [2] 3,263	38	1,455

[1] Cultivated pasture.
[2] Miscellaneous pasture, including native and poor cultivated.

As indicated in Table 2, alfalfa continues to occupy the largest acreage of any single crop and is grown each year on about one-fourth of the total cropped area of the project. While a small quantity of the alfalfa hay is marketed and shipped from the project, the larger part of it is used locally.

The sugar-beet acreage in recent years has remained between 4,000 and 5,000 acres except in 1928, when it dropped to 2,685 acres. The decrease in that year was due to the failure of growers and the sugar manufacturers to reach a satisfactory agreement as to the price to be paid for the crop. The yield of sugar beets has averaged about 10.4 tons per acre during the 18-year period 1913 to 1930, inclusive. In 1930 the yield was 14.13 tons, which was the highest in the history of the project.

Beans have become an important crop on the project in recent years, and in 1929 more than 4,000 acres were in this crop. The principal

variety grown is Great Northern, although garden seed beans are produced to a limited extent. The garden beans are grown under contract with eastern seed firms.

The acreage cropped to barley has also increased in recent years. The maximum amount of 2,332 acres was grown in 1929, and there was only slightly less than this in 1930. This crop yields well under conditions on the project and makes excellent feed for stock.

The production of wheat declined from 5,324 acres in 1928 to 1,455 acres in 1930. Low prices were responsible for this decline, and wheat has been replaced to a large extent as a cash crop by beans, for which prices have been more favorable.

Irrigated pastures are also an important crop on the project and occupy substantial acreages. While some of the land used for this purpose is included in the poorer, heavy soils, there are also more than 1,000 acres of the more productive land used for this purpose. These cultivated pastures for the most part are seeded to a mixture of grasses recommended in an earlier publication.[1] This mixture is found to have a high carrying capacity and to give returns that compare favorably with returns from other crops.

LIVESTOCK

Surveys made by the Bureau of Reclamation each year since 1914 indicate that there have been no significant changes in the numbers of the various classes of livestock on the Huntley project in recent years. It appears from observation of the conditions on the project that the livestock industries have not developed to the extent to which they could be developed with profit and that for a better balanced and more permanent type of farming more stock should be maintained on project farms. This apparent lack of interest in keeping more livestock is probably accounted for by the fact that a large number of these farms are operated by tenants who are interested mainly in growing cash crops.

The numbers of the various classes of livestock on project farms for the 17-year period 1914 to 1930, inclusive, are given in Table 3.

TABLE 3.—*Number of livestock on farms on the Huntley reclamation project, 1914–1930*

Year	Horses	Mules	Beef cattle	Dairy cattle	Sheep	Hogs	Fowls	Bees (hives)
1914	2,008	53	2,921		847	4,012	23,345	249
1915	1,901	53	3,816		6,198	4,860	18,758	288
1916	1,961	58	1,932	1,753	3,729	2,791	16,418	282
1917	2,145	80	1,795	1,949	1,974	2,353	16,920	296
1918	2,120	51	1,813	1,920	1,130	2,391	15,850	424
1919	2,297	46	2,031	2,040	2,115	3,097	21,456	458
1920	2,041	34	1,312	1,804	2,352	1,885	18,232	189
1921	1,865	58	1,765	1,542	1,480	1,365	18,500	442
1922	1,875	61	1,395	1,951	1,310	1,022	23,030	210
1923	1,547	33	751	1,534	2,384	1,190	20,214	193
1924	2,158	60	1,801	2,250	3,998	1,600	21,644	187
1925	2,027	45	1,658	1,908	7,439	1,572	24,015	435
1926	2,089	47	980	2,006	10,830	1,674	46,279	454
1927	1,898	42	911	1,640	4,739	1,676	23,141	148
1928	1,902	42	699	1,754	4,439	2,807	23,227	545
1929	1,944	56	772	2,308	4,820	1,929	24,537	584
1930	1,813	46	1,568	1,986	6,889	1,657	25,884	1,180

[1] HANSEN, D. IRRIGATED PASTURES. Mont. Agr. Expt. Sta. Bul. 166, 12 p., illus. 1924.

The largest number of sheep was reported in 1926. Probably two-thirds of these were lambs brought in from the range for winter feeding and fattening for market, although from 2,000 to 3,000 sheep are maintained on project farms the year around, principally in small farm flocks of usually not more than 100 head.

Beef cattle are for the most part brought to the project for fattening for market and are usually fed over a period of four to five months during the winter season. Sugar-beet by-products, including tops and pulp, are utilized as part of the ration for feeding both cattle and lambs.

The number of hogs on the project has usually not exceeded 2,000. In recent years the small number of hogs raised has hardly been sufficient to supply local demands.

The poultry industry has never been developed extensively, and the fowls are kept in small farm flocks of 100 birds or less.

In 1930 there were nearly 1,200 hives of bees, or more than double the number in any previous year reported, and there are a few fairly large apiaries. Sweetclover and alfalfa furnish the principal pasture for bees, and honey of excellent quality is produced.

IRRIGATED-CROP EXPERIMENTS

CROP ROTATIONS [1]

The principal investigational work with irrigated crops at the Huntley field station consists of an extensive series of crop-rotation experiments. These experiments include a total of 43 rotations and continuous cropping and involve the use of one hundred nine ¼-acre plots. Crops grown in these experiments are those of principal importance locally and include alfalfa, sugar beets, potatoes, oats, wheat, beans, corn, flax, and sweetclover. These crops are grown in rotations of various lengths of from one to six years and in various sequences and with various treatments.

The purposes of this experiment are to obtain information as to suitable rotations for this section and to determine the value of alfalfa, other legumes, and manure when used in the rotation. In order to measure the value of legumes and manure, similar rotations that do not include these crops and treatments are used for comparison. Each of the crops used in the experiment is also grown continuously on the same plot each year.

The first of the rotation work was begun in field K in 1912. In this field there are three 6-year, three 4-year, three 3-year, and eleven 2-year rotations in addition to 9 continuously cropped plots. In 1916 additional rotations were begun in field L–IV to supplement those in field K. These rotations involved the same crops as certain of the earlier rotations, but the crops were arranged in different sequences.

In 1927 two 4-year rotations, one 3-year rotation, and one continuously cropped plot were added to field L–I. These rotations included the use of beans and sweetclover, crops that are not included in any of the earlier rotations. In two of the rotations in field L–I sweetclover and corn are pastured by sheep. A list of all of the rotations in these experiments follows.

[1] See also the following publication: HASTINGS, S. H., and HANSEN, D. IRRIGATED CROP ROTATIONS IN SOUTHERN MONTANA. U. S. Dept. Agr. Tech. Bul. 144, 32 p., illus. 1929.

FIELD K

(Rotations begun in 1912)

Continuous Cropping

1. Oats.
2. Sugar beets.
3. Wheat.
4. Potatoes.
6. Corn.
8. Alfalfa.
9. Flax.
10. Sugar beets (manure).[3]
11. Corn (manure).[3]

Two-Year Rotations

16. Oats, corn.
18. Wheat, sugar beets.
20. Potatoes, sugar beets.
21. Potatoes (manure), sugar beets.
22. Oats, sugar beets.
23. Oats (manure), sugar beets.
24. Oats, potatoes.
25. Oats (manure), potatoes.
26. Potatoes, corn.
27. Oats (followed by rye plowed under), potatoes.
28. Wheat, oats.

Three-Year Rotations

30. Potatoes, oats, sugar beets.
31. Potatoes, oats (manure), sugar beets.
32. Corn, oats, sugar beets.

Four-Year Rotations

40. Potatoes, sugar beets, alfalfa (two years).
42. Oats, sugar beets, alfalfa (two years).
44. Potatoes, oats, alfalfa (two years).

Six-Year Rotations

60. Potatoes, oats, sugar beets, alfalfa (three years).
61. Potatoes, oats (manure), sugar beets, alfalfa (three years).
67. Corn (harvested by hogs), flax, sugar beets, alfalfa (three years, pastured by hogs the third year).

FIELD L–IV

(Rotations begun in 1916)

Continuous Cropping[4]

1–a. Oats (manure).
2–a. Sugar beets (manure).
4–a. Potatoes (manure).
6–a. Corn (manure).
8–a. Alfalfa (manure).

Three-Year Rotations

34. Potatoes, sugar beets, oats.
35. Potatoes (manure), sugar beets, oats.

Four-Year Rotation

46. Sugar beets, oats, alfalfa (two years).

Six-Year Rotations

64. Potatoes, sugar beets, oats, alfalfa (three years).
66. Corn (two years, harvested by hogs), oats, alfalfa (three years, pastured by hogs the third year).

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[3] These plots cropped continuously to wheat and straw returned from 1912 to 1926; begun in their present form in 1927.

[4] Continuously cropped plots in field L–IV manured every second year, beginning in 1927; not manured previous to that time.

FIELD L–I

(Rotations begun in 1927)

Continuous Cropping

12. Beans.

Three-Year Rotation

37. Wheat, beans (manure), beets.

Four-Year Rotations

47. Wheat (sweetclover), sweetclover (pastured by sheep), corn (harvested by sheep), sugar beets.

49. Wheat (sweetclover), sweetclover (pastured by sheep), sugar beets (manure), sugar beets.

The arrangement of the fields and the locations of the experiments in 1930 are shown in Figure 1.

The cultural practices for each crop in these rotations were as nearly as possible uniform each year. The practices were generally in keeping with what are considered to be timely and good farming methods; and while necessarily there were occasions when it was not possible to perform certain operations such as irrigating and cultivating exactly as appeared desirable, the treatment for each crop was in general the same in all of the rotations. While crop varieties in some cases were changed in order to use adapted or improved varieties, the variety was always the same each year in all of the rotations.

With 1930 the original rotations in field K completed the nineteenth year, and as the experiments have progressed the differences in returns from the different rotations have become more apparent. In general, the yields from the better rotations that include manure or alfalfa have been maintained or increased, while yields in most cases from continuous cropping and in short rotations that do not include manure or alfalfa are decreasing each year and have for several years been at such low levels as to be unprofitable.

In the following discussion, results in the rotations are considered under main crop heads.

SUGAR BEETS

Table 4 presents the yields of sugar beets in detail for the four years 1927 to 1930 and by 6-year periods from 1912 to 1929. By giving the results in averages for 6-year periods it is possible to show the trend of yields more accurately than by considering each year's yields separately, and to eliminate to a large extent variations in yield that might be due to seasonal differences.

TABLE 4.—*Annual acre yields of sugar beets (tons) at the Huntley field station for each year from 1927 to 1930 and average yields by 6-year periods from 1912 to 1929*

Rotation No.	Crop sequence	1927	1928	1929	1930	6-year average 1912–1917	6-year average 1918–1923	6-year average 1924–1929
2	Sugar beets (continuous)	9.22	7.72	8.17	8.31	8.91	9.06	8.22
2-a	Sugar beets (manure, continuous)	[1]11.31	6.87	13.76	9.87	.....	10.28	[2] 7.68
10	....do [3]	.....	16.61	18.88	20.49	.....	.....	.....
18	Wheat, sugar beets	8.44	[4] 1.33	6.72	2.56	9.04	7.13	5.85
20	Potatoes, sugar beets	12.10	11.04	9.93	13.40	12.14	12.56	11.49
21	Potatoes (manure), sugar beets	15.64	18.74	18.75	19.66	13.85	15.18	17.16
22	Oats, sugar beets	9.77	4.82	5.04	5.18	11.09	8.28	6.59
23	Oats (manure), sugar beets	15.39	14.23	19.71	19.30	12.58	12.25	16.32
30	Potatoes, oats, sugar beets	7.80	6.04	6.29	10.88	7.25	8.58	7.51
31	Potatoes, oats (manure), sugar beets	15.41	17.15	14.57	22.18	10.87	12.53	15.25
32	Corn, oats, sugar beets	8.89	7.82	7.16	7.84	7.59	11.21	9.07
34	Oats, potatoes, sugar beets	10.71	4.35	5.49	5.92	.....	13.15	7.81
35	Oats, potatoes (manure), sugar beets	15.48	12.90	17.23	17.54	.....	14.69	15.01
37	Wheat, beans (manure), sugar beets	16.84	14.15	16.00	23.38	.....	.....	[5] 17.50
40	Alfalfa (2 years), potatoes, sugar beets	14.56	13.79	8.28	5.92	11.85	12.27	13.58
42	Alfalfa (2 years), oats, sugar beets	14.24	10.55	4.00	4.70	9.60	11.13	10.27
46	Oats, alfalfa (2 years), sugar beets	7.69	33.15	6.03	5.01	.....	11.68	7.14
47	Wheat (sweetclover), sweetclover (sheep pasture), corn (sheep pasture), sugar beets	17.94	12.33	16.96	20.39	.....	.....	[5] 16.88
49	Wheat (sweetclover), sweetclover (sheep pasture), sugar beets (manure), sugar beets (first year)	15.57	13.78	20.76	18.55	.....	.....	[5] 17.17
49	Wheat (sweetclover), sweetclover (sheep pasture), sugar beets (manure), sugar beets (second year)	18.74	15.44	21.03	22.99	.....	.....	[5] 19.55
60	Alfalfa (3 years), potatoes, oats, sugar beets	14.32	11.51	7.97	15.07	9.86	13.55	13.49
61	Alfalfa (3 years), potatoes, oats (manure), sugar beets	19.25	19.40	17.15	16.56	14.80	16.26	17.34
64	Oats, alfalfa (3 years,) potatoes, sugar beets	13.75	11.19	10.42	8.00	.....	13.58	12.01
67	Alfalfa (3 years, third year pastured with hogs), corn (harvested with hogs), flax, sugar beets	18.23	17.84	17.62	16.24	13.49	16.01	17.26

[1] Manured every second year beginning in 1927; no manure previously.
[2] Average yield 1924–1926, 4.70 tons; 1927–1929, 10.65 tons.
[3] Cropped continuously to wheat 1912–1926; fallow in 1927 to destroy wild oats.
[4] First seeding resulted in stand failure; stand from second seeding poor.
[5] Rotations started in 1927; average given is for the 4-year period 1927–1930.

The results indicate that in the 2-year rotations not manured, yields have declined consistently in each period except in the case of rotation 20, in which potatoes alternate with sugar beets. In this rotation the last period only shows a decrease and this was not nearly so marked as in rotations where grains alternate with beets. The results in this rotation, as well as in others where beets follow potatoes, indicate that this is a good sequence. The greatest decrease in yield occurred in rotation 22, in which sugar beets follow oats. This rotation showed a decrease of 40 per cent. In rotation 18, in which the crops are wheat and beets, there was a decrease of 35 per cent between the first and last periods.

In rotation 21, in which the crops are potatoes and beets, which is directly comparable with rotation 20 except that the beets receive an application of manure each year, there has been a steady rise in yields, and the average yield of beets during the period 1924 to 1929 was 49 per cent greater than that of rotation 20.

In rotation 23, which consists of oats (manure) and sugar beets, there was a substantial increase in yields in the third over the first 6-year period, although the yields were practically the same in the second as in the first period. During the last six years this rotation gave an average yield of 16.32 tons per acre, as compared with 6.59 tons in rotation 22, in which the crops, oats and sugar beets, are the

same, but which does not receive manure. The increase, ascribed to the effect of the manure, amounted to 147 per cent.

Yields in the continuously cropped beet plot in field K remained at nearly the same level during the 18 years of the experiment. Comparable figures are not available for the continuously cropped beets in field L–IV, since this rotation was changed in 1927 and the plot has since been manured every second year. However, previous to that time the yields were declining rapidly and during the three years 1924 to 1926 averaged only 4.7 tons per acre. This loss in yield was due to the prevalence of black-rot disease (damping off), which has never been serious in the continuous beets in field K. This condition in the beets in field L–IV has apparently been corrected to a large extent by the application of manure, a yield at the rate of 11.31 tons having occurred the first year after manure was applied.

In considering beet yields in the 3-year rotations not manured, it appears that in the case of two of these rotations (Nos. 30 and 32) the yields have been maintained or slightly increased, while in a third case (No. 34) the yield has decreased. The decline in rotation 34 was due largely to black rot, which apparently affects beets to a much greater extent in all of the rotations in field L–IV than in those in field K, owing presumably, to some difference in soil conditions. This condition is apparently overcome when manure is applied, as indicated by yields in rotation 35, in which the crops and crop sequence are the same as in rotation 34 but in which manure is applied directly preceding the beet. The last 6-year average yield of beets in rotation 35 was at the rate of 15.01 tons per acre, as compared with a yield of 7.81 tons in rotation 34. The effect of manure is apparent again in a comparison of rotations 30 and 31, in which the crops are the same and the only difference in treatment is that manure is applied to the land for the beet crop in rotation 31. (Figs. 2 and 3.) Yields in the latter rotation increased consistently in each period and during the last six years averaged double those of rotation 30.

In the 4-year rotations the yields of sugar beets were maintained or slightly increased except in No. 46, in which sugar beets follow alfalfa directly and in which yields showed a marked decline in the six years 1924 to 1929. Here, again, in recent years there has been serious injury to the beet crop due to the presence of black rot. In rotation 40, in which the sequence is two years of alfalfa followed by potatoes and sugar beets, there has been a slight increase in the beet yields through each 6-year period. As compared with beet yields in rotation 20, in which the crops other than alfalfa are the same, the yield of beets in rotation 40 during the last 6-year period was slightly more than 2 tons higher, presumably owing to the effect of the alfalfa. Comparing yields in rotation 42 with those in rotation 22, in which the crops except alfalfa are identical, it is found that during the last six years beets in No. 42 outyielded those in No. 22 by 3.68 tons per acre, while during the earlier years of the experiment the yield of beets in the rotation containing alfalfa was less than that in the 2-year rotation of oats and beets. Although rotations 47 and 49 have been under way only four years, it is apparent from results so far obtained that the use of sweetclover (pastured by sheep), corn (harvested by sheep), and barnyard manure have had a definitely beneficial influence upon the yield of the succeeding beet crops. Four-year average yields of beets in these rotations have been from slightly less than 17 to more than 19.5 tons per acre. Rotation 37, in which

the crops are wheat, beans (manure), and sugar beets, has also given almost uniformly good returns since the rotation was started, in 1927.

FIGURE 2.—Sugar beets in rotation 30, in which the crops are potatoes, oats, and sugar beets. The beets in this rotation returned an average annual yield of 7.51 tons per acre during the six years 1924–1929, as compared with an average yield of 15.25 tons from rotation 31, in which the beets were manured each year

The beneficial effect upon yields of sugar beets of the use of both alfalfa and manure is indicated in the returns from the 6-year rotations

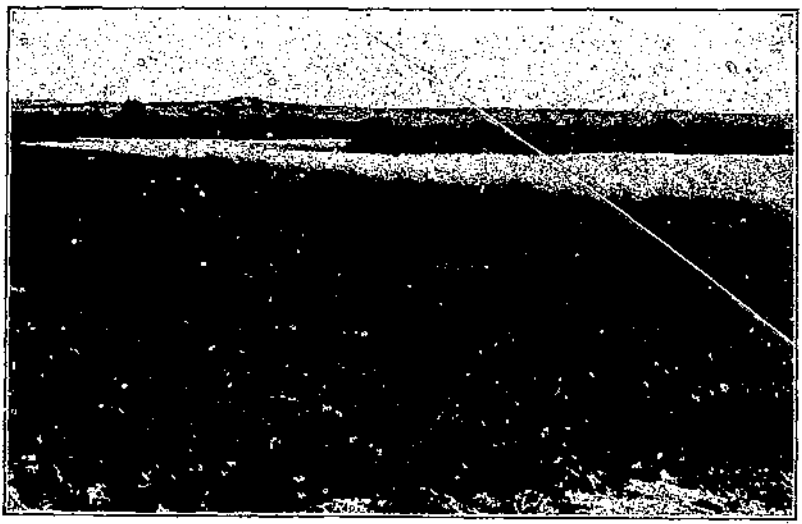

FIGURE 3.—Sugar beets in rotation 31, in which the crops are potatoes, oats (manure), and sugar beets. The average annual yield for the six years 1924–1929 was 15.25 tons per acre

61 and 67. In rotation 61 the yields have increased consistently from the beginning. In this rotation, in which the crops are three years of alfalfa followed by potatoes, oats, and sugar beets, manure is

applied preceding the beet crop. Rotation 60, which has the same crops but is not manured, returned a yield of beets of nearly 4 tons less. (Fig. 4.) Comparing the yields from these rotations respectively with those from Nos. 30 and 31, which have the same crops except alfalfa, it is seen that alfalfa and manure markedly benefit the yields of beets.

Rotation 67, in which the third-year alfalfa and corn are pastured by hogs, is not directly comparable with any of the other rotations, but the increasingly high yields of sugar beets in this rotation indicate the value of including alfalfa and of using livestock to graze some of the crops in the rotation.

In comparing yields in rotation 64 with those in rotation 60, between which rotations the only difference is the sequence of the crops, it is observed that there was a slight drop in yields in rotation 64 during the last 6-year period. Beets in rotation 64 outyielded those in rotation 34 by nearly 5 tons to the acre during the last six years. This is apparently due to three years of alfalfa in the longer rotation.

POTATOES

The yields of potatoes in the irrigated rotations are given in Table 5 in detail for the years 1927 to 1930 and by 6-year periods for the years 1912 to 1929.

TABLE 5.—*Annual acre yields of potatoes (bushels) at the Huntley field station for each year from 1927 to 1930 and average yields by 6-year periods from 1912 to 1929*

Rotation No.	Crop sequence	1927	1928	1929	1930	6-year average		
						1912–1917	1918–1923	1924–1929
4	Potatoes (continuous)	104.7	112.0	141.3	125.3	173.0	159.4	111.2
4-a	....do	[1] 162.7	155.3	222.0	235.3	.....	232.9	[2] 162.9
20	Beets, potatoes	188.0	75.3	155.3	120.0	245.2	222.8	151.9
21	Beets, potatoes (manure)	177.3	236.0	353.3	262.7	271.6	203.6	256.9
24	Oats, potatoes	115.3	106.6	154.0	124.0	248.2	190.7	140.6
25	Oats (manure), potatoes	277.3	233.3	281.3	350.0	327.8	325.5	285.2
28	Corn, potatoes	137.3	128.6	159.3	150.0	233.1	184.0	130.8
27	Oats (rye), potatoes	74.0	120.6	124.7	85.3	75.8	114.9	105.5
30	Oats, beets, potatoes	154.0	122.6	156.6	200.0	196.1	188.5	148.9
31	Oats (manure), beets, potatoes	190.0	188.6	153.3	251.3	179.3	182.9	170.3
34	Beets, oats, potatoes	160.0	133.3	172.7	191.3	.....	266.5	215.6
35	Beets, oats (manure), potatoes	268.7	282.6	348.7	274.7	.....	297.8	326.5
40	Beets, alfalfa (2 years), potatoes	252.7	196.0	262.0	267.3	239.6	273.1	277.1
44	Oats, alfalfa (2 years), potatoes	216.6	192.0	192.7	229.3	180.5	208.2	217.2
60	Oats, beets, alfalfa (3 years), potatoes	287.3	254.6	268.0	295.3	289.0	280.4	281.6
61	Oats (manure), beets, alfalfa (3 years), potatoes	292.0	272.6	330.3	369.3	308.8	310.1	309.6
64	Beets, oats, alfalfa (3 years), potatoes	339.3	268.0	294.7	351.3	.....	291.6	316.1

[1] Manured every second year beginning in 1927; no manure previously.
[2] Average, 1924-1926, 145.8 bushels; 1927-1929, 180 bushels.

The results indicate that based upon 6-year averages yields have shown a consistent decline in the continuously cropped plot and in the 2-year and 3-year simple rotations, while in the rotations that include manure or alfalfa, or both, yields have either been maintained near the original levels or have shown some increase in the later years of the experiment. Apparently, potato yields have been more favorably influenced by the effect of alfalfa in the rotations than by the use of manure. It must be noted, however, that in most of the manured rotations the manure is applied from two to five years preceding the

crop of potatoes; but even in rotations in which manure is applied immediately preceding the potatoes the yields in only one of the three rotations thus treated have tended to increase during the last 6-year period. This increase in yield occurred in rotation 35, in which the crops are sugar beets, oats (manure), and potatoes. In rotations 21 and 25, in which manure is applied directly preceding the potatoes, the yields were slightly less during the last 6-year period than in the first.

The lowest yield has resulted consistently from rotation 27, in which potatoes follow oats, with rye seeded in the oat stubble and plowed under for green manure the following spring before potatoes are planted. This appears to be a particularly poor practice, probably owing to the fact that in spring plowing in the heavy soils of this

FIGURE 4.—Sugar beets in rotation 61, in which the crops are alfalfa (three years), potatoes, oats (manure), and sugar beets. The average annual yield of beets in this rotation over a 6-year period was 17.34 tons per acre, as compared with 13.49 tons in rotation 60, which is not manured, and 7.51 tons in rotation 30, which contains neither manure nor alfalfa

field it is found difficult to obtain a satisfactory seed bed and the stand of potatoes has frequently been poor.

Continuous cropping to potatoes resulted in a steady decline in yields during each 6-year period. In one continuously cropped plot manure was applied every second year beginning in 1927, although prior to this time the plot was not manured. The crop showed a marked response in increased yields when manure was applied.

The beneficial effect on the yields of potatoes when alfalfa is included in the rotation is indicated in a comparison of alfalfa rotations with rotations that do not include alfalfa but are otherwise identical. The average yield of potatoes in four alfalfa rotations during the last 6-year period was 271.4 bushels per acre, while the average yield from four comparable rotations that did not contain alfalfa was 152.9 bushels, an increase in favor of the alfalfa rotations of nearly 78 per cent.

The effect of manure in the rotation on the yields of potatoes is indicated in a study of five pairs of comparable rotations. In each

pair the crops are identical, the only difference being that manure is applied in one and not in the other. The manured rotations during the last 6-year period gave an average yield of 269.7 bushels per acre, while the unmanured rotations gave an average yield of only 187.6 bushels per acre. The increase in favor of the manured rotations amounted to 82.1 bushels, or 43.8 per cent.

OATS

Yields of oats in the irrigated rotations each year for the years 1927 to 1930 and by 6-year periods from 1912 to 1929 are given in Table 6. Comparatively low yields have occurred in the 2-year rotations without manure, and the returns in these rotations have usually shown a decline each year during the later years of the experiment. In a rotation of wheat and oats, yields have been practically at the same low level as in the continuously cropped oats. In both of these rotations in recent years wild oats have become a serious factor adversely affecting yields.

TABLE 6.—*Annual acre yields of oats (bushels) at the Huntley field station for each year from 1927 to 1930, and average yields by 6-year periods from 1912 to 1929*

Rotation No.	Crop sequence	1927	1928	1929	1930	6-year average		
						1912–1917	1918–1923	1924–1929
1	Oats (continuous)	37.8	35.6	25.0	31.3	[1] 34.1	37.4	33.6
1-a	do	[2] 73.8	44.3	63.8	43.8	-------	60.3	[3] 51.6
16	Corn, oats	76.2	63.8	57.5	72.6	68.8	65.6	61.5
22	Sugar beets, oats	95.0	92.5	70.0	77.5	87.5	83.8	76.6
23	Sugar beets, oats (manure)	104.9	103.5	71.3	101.0	78.7	74.3	87.2
24	Potatoes, oats	81.2	83.8	62.5	70.5	83.4	71.6	71.9
25	Potatoes, oats (manure)	108.7	132.5	106.3	116.1	91.7	79.2	102.6
27	Potatoes, oats (rye, green manure)	61.6	63.5	42.5	40.6	61.3	57.4	56.1
28	Wheat, oats	43.0	56.5	30.0	26.0	[4] 37.3	[4] 45.9	41.2
30	Sugar beets, potatoes, oats	57.5	78.8	62.5	68.6	68.5	60.6	66.0
31	Sugar beets, potatoes, oats (manure)	83.7	107.5	63.8	67.0	74.3	64.9	80.8
32	Sugar beets, corn, oats	64.7	57.5	46.3	60.1	63.5	52.7	52.9
34	Potatoes, sugar beets, oats	83.8	63.8	76.3	65.8	-------	89.2	71.9
35	Potatoes, sugar beets, oats (manure)	95.0	86.3	80.0	91.4	-------	91.3	81.0
42	Sugar beets, alfalfa (2 years), oats	116.2	120.0	102.5	108.6	83.5	88.5	102.2
44	Alfalfa (2 years), potatoes, oats	116.2	130.0	83.8	108.8	75.8	80.4	101.0
46	Alfalfa (2 years), sugar beets, oats	106.2	127.5	92.5	110.6	-------	88.5	105.4
60	Sugar beets, alfalfa (3 years), potatoes, oats	121.2	137.2	103.8	123.9	85.3	90.4	114.9
61	Sugar beets, alfalfa (3 years), potatoes, oats (manure)	115.0	130.0	138.3	136.3	93.5	88.2	118.2
64	Alfalfa (3 years), potatoes, sugar beets, oats	96.2	108.8	92.5	95.6	-------	88.7	99.1
69	Alfalfa (3 years), third year pastured with hogs, corn (2 years, harvested with hogs), oats	106.2	123.8	112.5	113.9	-------	90.0	107.3

[1] No crop in 1916.
[2] Manured every second year beginning in 1927; no manure previously.
[3] Average, 1924–1926, 42.6 bushels; 1927–1929, 60.6 bushels.
[4] No crop in 1918 and 1919; 5-year average.

In the 2-year rotations in which oats follow a cultivated crop, yields have been slightly higher following sugar beets than following potatoes or corn. This has also held true in 3-year rotations in which these crops precede oats.

The use of manure in the rotation has in all cases had a stimulating effect on yields of oats, although manure is not applied directly to this crop but is used in the rotation from one to five years preceding the oats, depending upon the length of the rotation. In five rotations in which no manure was used the average yield of oats during the 6-

year period 1924 to 1929 was 80.4 bushels per acre. In five comparable rotations in which the crops were identical with those in the first five rotations but in which manure was applied at some period in the rotation, the average yield of oats was 94 bushels per acre. This was a difference of 13.6 bushels, or an increase of 17 per cent in favor of the manured rotations.

The use of alfalfa in the rotation has resulted in still greater increases in yields of oats than has the use of manure. In most cases, however, alfalfa is only one crop removed from oats, and in one case oats directly follows this crop. In five pairs of comparable rotations oats yielded during the last 6-year period in rotations without alfalfa at an average rate of 73.4 bushels per acre, while in rotations that include alfalfa the average during this time was 107.1 bushels, an increase of 33.7 bushels per acre, or 46 per cent. In general, the yields of oats in rotations that include alfalfa or manure or both have tended to increase during the last 6-year period over yields obtained during the first or second 6 years, while in the 2-year and 3-year rotations not so treated the yields have declined as the experiment has progressed.

CORN

Corn is a crop of minor importance in this section and occurs in only nine of the rotations. In two of these the corn is pastured by hogs and in another by sheep. The results from these pastured plots are considered in this report under "Pasturing irrigated crops by hogs and sheep" (p. 22). Results from the harvested plots are given in Table 7.

Yields of corn have been maintained at near the original levels in the 2-year and 3-year rotations, as indicated by average yields during the three 6-year periods. Corn in a 2-year rotation with potatoes has outyielded corn in a rotation with oats by about 10 bushels per acre, and this difference has been fairly constant throughout the 18 years of the experiment. Corn following beets in a 3-year rotation of oats, sugar beets, and corn has given a lower return during each 6-year period than has corn in the rotation with potatoes. The lowest yield was obtained in the continuously cropped plots, and these have shown a marked decrease during the last period. In rotation 6–a there was a marked response in yield when manure was applied in 1927 and 1929. The average yield for the 3-year period 1924 to 1926 was at the rate of only 30.5 bushels, while the average yield for the three years 1927 to 1929, in which manure was applied in two of the three years, was increased to 43.8 bushels.

WHEAT

Wheat is grown in but three of the rotations that were started in 1912 and is included in three of the rotations begun in 1927 in field L–I. Yields of wheat each year from 1927 to 1930 and by 6-year periods from 1912 to 1929 are given in Table 8.

TABLE 7.—*Annual acre yields of corn (bushels) at the Huntley field station for each year from 1927 to 1930 and average yields by 6-year periods*

Rotation No.	Crop sequence	1927	1928	1929	1930	6-year average		
						1912–1917	1918–1923	1924–1929
6	Corn (continuously)	24.5	22.7	10.1	24.2	32.8	28.7	19.3
6-a	do	[1] 39.8	44.3	47.3	42.4	------	45.8	37.1
11 [2]	Corn (manure) continuously	------	63.0	46.1	59.3	------	------	[3] 56.3
16	Oats, corn	27.3	41.3	23.3	41.2	35.1	39.6	32.5
26	Potatoes, corn	37.5	45.6	38.3	46.4	43.9	48.2	43.3
32	Oats, sugar beets, corn	42.6	41.8	25.9	37.3	38.1	45.9	37.5

[1] Manured every second year beginning in 1927; no manure previously.
[2] Rotation started in 1928. This plot cropped continuously to wheat from 1912 to 1926, inclusive. Fallow in 1927 to destroy wild oats.
[3] Average 1928 to 1930, inclusive.

Yields in the continuously cropped plot and in the 2-year rotation No. 28, in which wheat alternates with oats, have been extremely low almost from the beginning of the experiment. Soon after these cropping systems were begun these plots became infested with wild oats, which has been one of the chief factors in limiting yields. Yields in rotation 18, in which wheat alternates with sugar beets, have been maintained at near the same level during most of the years of the experiment.

In rotations 37, 47, and 49, which were started in 1927 and in which wheat in each case follows sugar beets, wheat occupies a more favorable place in the rotation, and increasingly high yields have been obtained during the four years.

TABLE 8.—*Annual acre yields of wheat (bushels) at the Huntley field station for each year from 1927 to 1930 and average yields by 6-year periods from 1912 to 1929*

Rotation No.	Crop sequence	Yield, bushels per acre						
		1927	1928	1929	1930	6-year average		
						1912–1917	1918–1923	1924–1929
3	Wheat, continuous	5.8	19.3	9.3	11.1	21.1	18.0	13.6
18	Sugar beets, wheat	45.0	35.4	36.7	34.0	37.3	20.5	37.3
28	Oats, wheat	11.5	22.9	11.3	16.8	17.4	19.4	15.7
37	Beans (manure), sugar beets, wheat	33.5	42.0	36.7	47.5	------	------	[1] 39.9
47	Sweetclover (pastured by sheep), corn (harvested by sheep), sugar beets, wheat (sweetclover)	28.7	36.0	31.3	43.4	------	------	[1] 34.9
49	Sweetclover (pastured by sheep), sugar beets (manure), sugar beets, wheat (sweetclover)	29.3	46.0	41.3	49.0	------	------	[1] 41.6

[1] Rotations started in 1927; average yields are for the 4-year period 1927–1930.

FLAX

Flax appears in but two cases in the rotation experiments. In one case it is grown continuously on the same plot and in another in a 6-year rotation of alfalfa (three years), corn, flax, and sugar beets. In this rotation the third-year alfalfa and the corn are harvested by

hogs. Exceptionally high yields of flax have been obtained in this 6-year rotation. Returns from continuous cropping were low after the first two or three years, and during the last 6-year period the average yield was only about one-half the yield during the first 6-year period.

Yields in the 6-year rotation would indicate that flax might be grown with the expectation of obtaining satisfactory yields on irrigated lands under certain favorable conditions. There are, however, some difficulties in handling flax as an irrigated crop unless the field is uniformly drained so that maturity of the crop is uniform. The presence of low, poorly drained spots in a field causes continued blooming and uneven ripening of the crop.

Yields of flax for the years 1927 to 1930, as well as average yields by 6-year periods from 1912 to 1929, are given in Table 9.

TABLE 9.—*Annual acre yields of flax (bushels) at the Huntley field station for each year from 1927 to 1930 and average yields by 6-year periods from 1912 to 1929*

Rotation No.	Crop sequence	1927	1928	1929	1930	6-year average		
						1912–1917	1918–1923	1924–1929
9	Flax (continuous)	4.3	6.3	4.3	7.4	10.8	6.4	5.3
67	Sugar beets, alfalfa (3 years, third year pastured by hogs), corn (harvested by hogs), flax	33.2	27.4	22.9	22.6	29.9	21.1	25.8

BEANS

Beans were not included in any of the original rotations, as this crop has not been of local importance until within recent years. A 3-year rotation of sugar beets, wheat, and beans (manure) was started in the new rotations in field L–I in 1927. Also beans are grown continuously on one plot in this field. The variety grown is Great Northern, which is the principal variety in the locality. Satisfactory yields were produced during the four years both in the continuously cropped plot and in the rotation, although there was some evidence of injury from mosaic disease in the plot continuously in beans the last two years. Yields and related data are given in Table 10.

TABLE 10.—*Annual acre yields of beans (bushels) in the irrigated rotation experiments at the Huntley field station, 1927–1930*

Rotation No.	Crop sequence	1927	1928	1929	1930	Average
12	Beans (continuous)	41.1	36.4	31.1	37.1	36.4
37	Sugar beets, wheat, beans (manure)	44.9	34.1	38.9	42.1	40.0

MAXIMUM CROP PRODUCTION

A cropping experiment to test the maximum yielding capacity of irrigated soils at the Huntley station has been under way since 1926. In this experiment it has been the aim to embody such cultural meth-

ods and crop sequences as have been found conducive to high yields in the older irrigated rotation experiments and in other cropping work of the station.

The experiment involves the use of eleven ¼-acre plots, and seven crops of local importance are grown in a combination of two rotations, although slight changes have been made in the crop sequence at various times. The entire series was in alfalfa for several years prior to beginning the experiment. During 1926 and 1927 seven plots remained in alfalfa, and the other crops included in the series during these two years were corn, potatoes, oats, and sugar beets. In 1928 wheat and beans were added. From 1928 to 1930, inclusive, two of the five alfalfa plots were broken up each year, one being followed by corn and the other by potatoes. Oats followed corn and beans followed oats. Beets were grown after potatoes, and wheat after beets. Before plowing in the fall, manure at the rate of 16 spreader loads per acre was applied to the plots to be planted to cultivated crops. For the grain crops the land was not manured or plowed but was prepared by the use of disk and harrow or duck-foot cultivator and harrow immediately before seeding. In 1930 for the first time treble superphosphate was applied at the rate of 100 pounds per acre to sugar beets, wheat, and oats at the time of seeding. Table 11 presents the yields obtained in this experiment.

TABLE 11.—*Annual acre yields in maximum crop-production experiment at the Huntley field station, 1926–1930*

Crop	1926	1927	1928	1929	1930	Average
Alfalfa, third year.....tons		5.86	5.88	5.92	6.93	6.16
Corn.....bushels	72.5	65.7	69.2	60.4	60.0	65.6
Potatoes.....do	490.6	560.0	492.6	563.7	336.0	488.6
Oats.....do	92.5	121.2	136.3	128.7	121.6	120.1
Sugar beets.....tons	22.34	22.00	22.00	19.96	24.51	22.16
Wheat.....bushels			65.3	58.0	76.6	66.6
Beans.....do			48.3	48.9	42.7	46.6

Except for seasonal variations, yields have been fairly uniform. The years 1929 and 1930 were not especially favorable for corn, and the yield of 60 bushels in each of these years was less than during the preceding years. In both 1929 and 1930 it was necessary because of drought to irrigate early to provide moisture for seed germination, and this situation reacted unfavorably on stands and on the early growth of some of the crops. A comparison of average yields in this experiment with the averages obtained on the Huntley project over the same period indicates that the irrigated lands of the project have possibilities of producing yields materially in excess of those formerly considered possible.

EXPERIMENTS WITH BEANS

Experiments with field beans have been carried on at the Huntley station in cooperation with the Montana Agricultural Experiment Station since 1925. These experiments have included tests of a large number of selections, comparative-yield tests with dry-land and irrigated seed, and fertilizer tests, all with the Great Northern variety.

BEAN SELECTIONS

Beginning in 1925, a large number of individual plant selections of Great Northern beans have been made each year. These selections were made with a view to improving type, yield, and disease resistance of this variety. The disease chiefly considered is mosaic. All selections were grown the first year in 40-foot rows, and those that appeared to warrant further trial were grown in succeeding years in larger plots for comparative yield tests and observations on disease resistance.

During the first years of this selection work, disease did not appear to be a serious factor in any of the selections; but in recent years it has become more prevalent, and because of this many of the selections that had previously been considered to be of some value from the standpoint of yield were discarded in 1930. A small number of the earlier selections that appear to be comparatively free from disease and that yield well are being retained for further trial.

In most commercial fields of Great Northern beans two distinct types of pods are found. One of these is of the clear, wax type, and the other is heavier and has bluish stripes. Beans of each of these types were selected in 1924, and these have been grown in comparative yield tests each year since that time with the exception of 1929. Yields obtained in this test are given in Table 12. The results indicate that the clear-pod type has returned uniformly higher yields each year.

TABLE 12.—*Comparative annual acre yields of clear-pod and striped-pod type Great Northern beans (pounds) at the Huntley field station 1925–1930, excluding 1929*

Type	1925	1926	1927	1928	1930	Average
Clear pod	2,264	1,490	2,842	1,707	1,517	1,964
Striped pod	1,947	1,400	2,602	1,543	1,406	1,770

IRRIGATED AND DRY-LAND BEAN SEED

Yield tests of Great Northern beans from seed grown on irrigated land in comparison with dry-land seed have been conducted for four years, beginning in 1926. The seed used in this test was produced originally from the same source. Observations on disease conditions indicated that the beans grown from dry-land seed may have been somewhat less affected by bean mosaic. In three of the four years of the experiment the yields were in favor of the dry-land seed, although the average yields for the four years are slightly in favor of the seed grown under irrigation. The results thus far do not indicate that there is any significant difference. The yields are given in Table 13.

TABLE 13.—*Average annual acre yields of beans (pounds) from seed grown under irrigation and under dry-land conditions, Huntley field station, 1926, 1927, 1928, and 1930*

Source of seed	1926	1927	1928	1930	Average
Irrigated	1,504	2,869	2,113	1,574	2,030
Dry land	1,632	2,525	2,285	1,608	2,012

FERTILIZER EXPERIMENT

In 1930 a test of phosphate fertilizer for beans was begun. This fertilizer was a treble superphosphate analyzing 42 per cent available phosphoric acid and was applied at the rate of 100 pounds per acre at the time of preparing the seed bed. In this test two plots were fertilized and two check plots were not fertilized. The average yield of the fertilized plots was at the rate of 2,240 pounds per acre, and from the check plots the average yield was 2,224 pounds, a difference not sufficient to be significant.

EXPERIMENTS WITH SUGAR BEETS

FERTILIZER EXPERIMENT

In 1929 and 1930 an experiment with commercial fertilizers for sugar beets was conducted in cooperation with the Division of Soil Fertility of the Bureau of Chemistry and Soils. This experiment is the standard "triangle" experiment carried on by this bureau in several western beet-growing sections and includes the use of nitrogen, phosphoric acid, and potash fertilizers in various proportions as well as each fertilizer element separately. The fertilizer was applied in one operation with the seed at the time of seeding and was used at the rate of 200 pounds total or 40 pounds of plant food per acre.

In 1929 the results indicated that where superphosphate was applied increases in yield varying from 2.5 to 5 tons per acre were obtained, while from the nitrogen and potash fertilizer there was apparently no response in yield of beets. In 1930, when the experiment was conducted in a different field, there were no significant differences in yield that might be attributed to the effect of the fertilizers.

In both years the method of applying the fertilizer directly with the beet seed was satisfactory and produced no bad effects except on plots where nitrogen fertilizer was applied at the heavier rates. In these cases the stands were not satisfactory, and the fertilizer apparently had a depressing effect on the early growth of the beets. On the plots on which superphosphate and potash were applied perfect stands were obtained each year, and in 1929 the early growth of beets on the phosphate plots was more vigorous than that on adjoining unfertilized plots.

METHOD OF THINNING

In 1926 and 1927 an experiment was conducted with sugar beets to determine the effect on yield of leaving the larger plants at thinning time. Commonly not much consideration is given by laborers to the size and vigor of the plants that are left, so long as the stand approximates the desired distance of 12 inches apart in the row. In this experiment special care was taken in one case to leave the larger and more vigorous plants, while in another case for comparative purposes the beets were thinned in the usual way. The experiment was conducted in duplicate, and in all respects other than in the thinning the cultural operations were uniform. Yields are presented in Table 14. In both years the results were in favor of the plots on which the large beets were left at thinning, the average difference amounting to 1 ton per acre in the two seasons.

TABLE 14.—*Annual acre yields of sugar beets (tons) in method-of-thinning experiment, with the different methods of thinning at the Huntley field station in 1926 and 1927*

Method of thinning	1926	1927	Average
Large plants	17.32	15.61	16.47
Plants not selected	16.01	14.92	15.47

FERTILIZER TESTS WITH POTATOES

Tests of commercial nitrogen fertilizer for potatoes were made from 1927 to 1929, inclusive, and of superphosphate in 1929 and 1930. The nitrogen fertilizer was in the form of ammonium sulphate and was applied at the rate of 400 pounds per acre directly to the potato row at the time of planting. The land used in the nitrogen experiment had never been cropped to alfalfa but was manured for the crop preceding each crop of potatoes. The crop preceding potatoes for 1927 was sugar beets, and for 1928 and 1929 the preceding crops were beans each year. The results are given in Table 15.

TABLE 15.—*Annual acre yields of potatoes (bushels) in nitrogen fertilizer tests at the Huntley field station, 1927–1929*

Ammonium sulphate per acre	1927	1928	1929	Average
400 pounds	430.7	473.3	390.6	431.5
No fertilizer	322.7	386.6	393.2	367.5

Table 15 indicates that in 1927 and 1928 there was a marked increase in yield in favor of the fertilized plots, the average for the two years amounting to nearly 100 bushels per acre, while in 1929 the yields from the fertilized and check plots were approximately the same, the slight difference being in favor of the check plot. The average difference in favor of the fertilized plot for three years was at the rate of 64 bushels per acre.

The phosphorous fertilizer used in the experiment in 1929 and 1930 was treble superphosphate, testing about 43 per cent available phosphoric acid. This fertilizer was applied at the rate of 100 pounds per acre directly at the time of planting. The results of the two years' tests as presented in Table 16 indicate that there was only a slight increase in yield due to the effect of the fertilizer, the average difference in yield between the fertilized and check plots amounting to 13.1 bushels per acre.

TABLE 16.—*Annual acre yields of potatoes (bushels) in phosphate fertilizer test at the Huntley field station, 1929 and 1930*

Fertilizer per acre	1929	1930	Average
100 pounds	410.6	396.6	403.6
No fertilizer	396.0	385.0	390.5

PASTURING IRRIGATED CROPS BY HOGS AND SHEEP

In certain of the irrigated rotations livestock is used to graze alfalfa and sweetclover and to harvest corn. Hogs are used in rotations 67 and 69 to graze the third-year alfalfa and harvest the corn crop, while sheep are used in rotations 47 and 49 to graze sweetclover and in rotation 49 to harvest corn. Rotations 67 and 69 are 6-year rotations, the former including three years of alfalfa followed by corn, flax, and

sugar beets, and the latter comprising three years of alfalfa followed by corn two years and oats. Rotation 67 was started in 1912 and rotation 69 in 1917. In rotation 47 the crops are wheat, sweetclover (pastured by sheep), corn (harvested by sheep), and sugar beets. The crops in rotation 49 are wheat, sweetclover (pastured by sheep), sugar beets, and sugar beets (manured). These rotations were started in 1927.

ALFALFA, FIELD CORN, AND RAPE FOR HOGS

The pasture season for alfalfa in rotations 67 and 69 is divided into two periods. Fall pigs that have been carried through the winter on a maintenance ration are used during the first period. They are started on the alfalfa at the beginning of the pasture season, which is usually about May 5, and remain until about July 1. For the remainder of the season, which usually extends to September 10, spring pigs are used on the pasture. The pigs while on the alfalfa pasture are fed corn at the rate of 2 pounds of corn for each 100 pounds live weight of the animals. When placed on pasture, the fall pigs weigh from 100 to 125 pounds each and the spring pigs about 50 pounds. Five fall pigs and eight spring pigs are used on the ¼-acre plot, so that the pasture has a carrying capacity of from 2,000 to 3,000 pounds live weight of pigs per acre. The results of pasturing alfalfa by pigs are given in Table 17. The difference in rate of gain between fall and spring pigs is attributed to the difference in size of the pigs when started on pasture.

TABLE 17.—*Results of pasturing third-year alfalfa (¼-acre plots) in irrigated rotations by eight spring and five fall pigs receiving a 2 per cent ration of corn on pasture at the Huntley field station, 1927–1930, and for the 17-year period 1914–1930*

Field and year	Pasturing periods	Total weight of pigs		Gain in weight			Corn ration per 100 pounds of gain	
		Initial	Final	Total	Average daily		Fall pigs	Spring pigs
					Fall pigs	Spring pigs		
	Days	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pound*	*Pounds*	*Pounds*
K, 1927	129	1,000	1,704	704	1.21	0.62	211	259
L, 1927	129	1,000	1,663	663	1.09	.61	233	261
K, 1928	122	1,178	1,884	706	1.38	.60	255	257
L, 1928	122	1,139	1,887	748	1.40	.66	246	234
K, 1929	123	1,124	1,843	719	1.17	.71	315	193
L, 1929	123	1,091	1,791	700	1.16	.69	310	199
K, 1930	126	1,095	1,835	740	1.23	.71	250	234
L, 1930	126	1,092	1,773	681	1.11	.66	273	242
Average, 1914–1930	131	944	1,545	601	1.01	.54	303	248

In rotation 67 the pigs from the alfalfa pasture are used after the pasture season to "hog off" the plot of corn. Five pigs are used on the quarter-acre plot, and an average of 25 days are required to consume all of the corn. In rotation 69 the two ¼-acre plots of corn are also hogged off. In these plots rape is seeded at the time of the last cultivation. This crop usually is about 12 inches high when the corn is matured and furnishes a good supplemental feed for the pigs. The results of hogging corn and rape in these two rotations, calculated to an acre basis, are presented in Table 18.

TABLE 18.—*Results of "hogging off" corn alone and corn and rape at the Huntley field station, 1927–1930, and average results 1912–1930*

Items of comparison	Rotation 67, corn alone					Rotation 69, corn and rape				
	1927	1928	1929	1930	Average, 1912–1930	1927	1928	1929	1930	Average, 1916–1930
Pigs per acre.....number	24	24	20	20	22	20	20	20	20	18
Days on test.....do	26	20	33	35	25	29	26	34	32	33
Total weight per lot per acre:										
Initial.....pounds	3,200	2,832	2,200	2,872	2,290	2,660	2,326	2,214	2,794	1,745
Final.....do	3,780	3,748	2,776	3,460	2,984	3,286	3,136	2,720	3,422	2,498
Total gain per acre.....do	560	916	576	588	694	626	810	506	628	753
Estimated yield of corn per acre.....bushels	62.6	77.0	73.6	50.0	61.4	57.5	72.0	72.9	55.0	60.0
Estimated grain per 100 pounds gain.....pounds	620	471	716	476	495	604	497	807	490	452

The results indicate a slight advantage in favor of the corn and rape over corn alone. The estimated amount of grain required per 100 pounds of gain was also in favor of the plots containing rape.

SWEETCLOVER AND FIELD CORN FOR SHEEP

Sweetclover in rotations 47 and 49 is seeded with wheat as a nurse crop and used as pasture for sheep. The pastures are divided into two parts which are grazed alternately in periods of from 10 days to two weeks each. Each part is irrigated when the sheep are removed, in order to promote maximum growth. The one-fourth acre of pasture during each of the three years reported here has had an average carrying capacity at the rate of six to eight ewes and their lambs per acre over an average grazing period of about 100 days. In each year except 1930 the ewes lost weight on pasture; in 1930 on rotation 49 the ewes made slight gains. The average rate of gain made by the lambs per acre was 340 pounds in rotation 47 and 320 pounds in rotation 49. The results in detail are given in Table 19.

TABLE 19.—*Results of pasturing sweetclover by ewes and lambs in rotations 47 and 49 at the Huntley field station, 1928–1930*

Items of comparison	Rotation 47				Rotation 49			
	1928	1929	1930	Average	1928	1929	1930	Average
Days.....number	129	103	96	109	112	103	96	104
Ewes.....do	[1] 2	3	2	-------	[1] 2	4	2	-------
Lambs.....do	[1] 4	6	3	-------	[1] 4	4	3	-------
Total weight of ewes per lot:								
Initial.....pounds	584	515	347	482	575	799	351	575
Final.....do	491	441	312	415	476	742	363	527
Gain or loss.....do	−93	−74	−35	−67	−99	−57	12	−48
Total weight of lambs per lot:								
Initial.....do	400	394	165	320	455	269	186	303
Final.....do	492	441	281	405	522	317	311	383
Gain.....do	92	47	116	85	67	48	125	80
Average weight per ewe:								
Initial.....do	150.5	171.7	173.5	165.2	156.5	199.8	175.5	177.3
Final.....do	117.5	147.0	156.4	140.3	115.5	185.5	181.6	160.9
Average gain or loss.....do	−33.0	−24.7	−17.1	−24.9	−41.0	−14.3	6.1	−16.4
Average weight per lamb:								
Initial.....do	58.5	65.7	55.0	59.1	63.3	67.3	62.0	64.2
Final.....do	77.5	73.5	93.7	81.6	80.5	79.3	103.7	87.8
Average gain per lamb.....do	21.0	7.8	38.7	22.5	17.2	12.0	41.7	23.6

[1] 2 additional ewes and 4 additional lambs were placed on each pasture for a short period in the early part of the season because of extra growth of the pasture.

Lambs are used to harvest the ½-acre corn plot in rotation 47. The lambs are placed on the corn plot a short time before the corn is matured and usually eat all the leaves before starting on the ear corn. While on the corn they have access to all the alfalfa hay they will consume. Table 20 presents the results of harvesting corn by sheep in this rotation.

TABLE 20.—*Results of harvesting corn by sheep in rotation 47 at the Huntley field station, 1927–1930*

Items of comparison	1927	1928	1929	1930	Average
Days.....number	40	40	42	27	41
Lambs.....do	7	10	10	10	
Total weights:					
Initial.....pounds	700	876	816	1,013	851
Final.....do	737	1,052	934	1,129	963
Gain.....do	37	176	118	116	112
Average weights per lamb:					
Initial.....do	100.0	87.6	81.6	101.3	92.6
Final.....do	105.3	105.2	93.4	112.9	104.2
Gain.....do	5.3	17.6	11.8	11.6	11.6
Daily gain.....do	.11	.38	.28	.43	.30
Feed per 100 pounds gain:					
Corn.....do	1,500	306	593	603	750
Alfalfa hay.....do	1,400	682	924	724	933
Total hay consumed.....do	500	1,200	1,096	840	907
Estimated acre yield of corn.....bushels	40.0	45.0	50.5	50.0	46.4

DRY FARMING [6]

Experiments with crops on the nonirrigated land of the station have been conducted since 1912 under the supervision of the Division of Dry Land Agriculture, Bureau of Plant Industry, in cooperation with other branches of the Department of Agriculture and with the Montana Agricultural Experiment Station.

The work consists of (1) growing the common field crops in a series of rotations and by several methods of tillage, (2) variety testing of cereals, beans, potatoes, forage crops, and garden crops, and (3) pasturing annual and perennial crops by hogs. In addition, soil-moisture determinations are made on specified plots throughout each season for the purpose of gathering data on moisture penetration, conservation, and depletion, in relation to various cropping and tillage treatments.

The four years covered by this report embrace from the standpoint of dry-land agriculture one of the most productive (1927) and one of the least productive (1930) seasons in the history of the station. In 1927, a year of abundant rainfall and favorable growing conditions, all crops produced relatively high yields irrespective of the tillage method employed. In 1928, precipitation, temperature, and length of frost-free period were below average, and yields were below average for most crops and under most cultural treatments. Satisfactory yields were obtained, however, from crops produced on lands cultivated with a view to moisture conservation and weed control.

The precipitation for 1929 was next to the lowest that has been recorded at the station. Other climatic factors were likewise unfavorable to crop growth. These conditions and the residual effect of the preceding dry year resulted in crop returns generally lower than those in 1928. Approved tillage methods again were reflected in fair yields, although the difference between high-producing and low-producing methods was less in 1929 than in the previous year.

[6] Report prepared by A. E. Seamans.

The year 1930 was the third consecutive one in which both the annual and the seasonal precipitation were below the average. Light rainfall in the spring together with the scarcity of moisture in the soil at seeding time made starting conditions unusually difficult for most crops. As the season advanced the continued drought in addition to high temperatures resulted in very low yields or complete failures of all crops grown in the dry-land experiments. The growing season of 1930 was the most severe on crops yet experienced at the station.

ROTATION AND TILLAGE EXPERIMENTS

WINTER WHEAT

The Kharkof variety of winter wheat has been used in the rotation experiments since they were begun. This crop yielded well in 1927, the average returns being considerably above the 1913 to 1930 average for all rotations and tillage treatments. As is commonly the case in seasons of favorable rainfall and growing conditions, the differences between the yields of winter wheat from the various tillage methods employed were less than normal, and a relatively satisfactory crop was obtained when even the poorest practices were followed.

The abundance of moisture accumulated in land fallowed during the unusually wet season of 1927 produced in 1928 yields of winter wheat on fallow somewhat above the average. The returns were less than the average.

Winter wheat grown on summer-fallowed land produced in 1929 the highest yields from any of the comparable treatments, but in nearly all of the experiments the returns were less than those harvested in 1928 and were much below the average returns for the period 1913 to 1930.

Because of winter-killing, soil drifting, and spring drought, the stands of winter wheat were poor in 1930, and the plots were reseeded to spring wheat. Drought and hot weather destroyed the wheat in most of the experiments, and on only three plots did the crop grow tall enough to be harvested. The yields obtained from the plots harvested were extremely low.

Table 21 presents the average yields of winter wheat from the various rotations and tillage methods for each of the years under review and for the period 1913 to 1930.

TABLE 21.—*Annual acre yields of winter wheat following different methods of tillage and crop sequences at the Huntley field station, 1927–1930, and for the 18-year period 1913–1930*

Seed-bed preparation	Preceding crop	Plots averaged	Average acre yield				
			1927	1928	1929	1930 [1]	1913–1930
		Number	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*
Fall plowed	Winter wheat	4	24.8	5.8	6.4	0	11.3
Subsoiled	do	1	29.7	11.0	9.2	0	12.6
Listed	do	1	21.0	10.8	5.3	0	11.9
Disked grain stubble	do	5	28.4	4.5	4.1	0	10.5
Disked corn stubble	Corn	4	37.5	9.3	12.8	0	18.5
Fallow	Fallow	10	37.7	32.0	15.0	1.3	26.4
Green manured	Winter rye	2	32.0	16.4	8.0	0	18.1
Do	Peas	2	30.3	18.5	10.0	0	22.2
Total or average		29	32.9	17.0	10.3	.5	[2] 19.7

[1] Loss of stand of winter wheat through winter injury and soil drifting necessitated reseeding the plots to spring wheat in 1930, and the yields presented under 1930 are for spring wheat instead of winter wheat.

[2] Because the number of plots was increased after the experiment was begun, the figure given is the average of the average yields obtained each year and not the average of the average yields shown for each method.

SPRING WHEAT

Forty-one plots of Kubanka spring wheat were included in the rotation and tillage investigations each year. In these experiments the crop was grown after corn, oats, flax, winter rye, field peas, sweetclover, and spring wheat. The tillage included spring plowing, fall plowing, summer fallowing, listing, subsoiling, disked grain stubble, disked corn stubble, and green manuring.

As was the case with winter wheat, yields of spring wheat during the very favorable year of 1927 were much above the average, and the differences in yield from the various treatments were comparatively small. The highest yield was from a rotation of wheat following flax; summer-fallowed land came next, and the third highest yield was on spring-plowed cornland. Experiments in which spring wheat followed itself were among the least productive.

Yields of wheat in 1928 were all much below those of 1927 and with but few exceptions were below the average for the period of experimentation. Spring wheat grown on fallowed land, on fall-plowed cornland, and following winter rye in a green-manure rotation produced yields above the average.

All rotations returned small yields of spring wheat in 1929. With one exception these yields were less than those harvested in 1928 and were much below the 18-year average of the experiments.

In 1930, the third of a succession of dry years, spring wheat planted on land that had been summer-tilled for three years was the only wheat producing a crop that could be gathered with a binder. The yield obtained on that plot was 21.7 bushels to the acre. Although two other plots of wheat on fallow were harvested, they yielded less than 4 bushels to the acre. On all the other plots the crop dried up before maturity, and no grain was harvested.

The average yields of spring wheat grown in the various rotation and cultural experiments are summarized in Table 22.

TABLE 22.—*Annual acre yields of spring wheat from different methods of tillage and crop sequence at the Huntley field station, 1927–1930, and for the 18-year period 1913–1930*

Seed-bed preparation	Preceding crop	Plots averaged	Average acre yield				
			1927	1928	1929	1930	1913–1930
		Number	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*
Fall plowed	Corn	1	23.0	15.2	6.3	0	13.4
Do	Oats	2	23.5	10.4	6.6	0	13.0
Do	Wheat	3	20.1	9.3	5.8	0	10.7
Spring plowed	Corn	1	27.0	7.0	6.8	0	13.6
Do	Oats	1	22.8	6.0	8.5	0	10.9
Do	Wheat	1	24.2	3.8	2.8	0	9.8
Do	Flax	1	29.2	11.7	8.5	0	12.7
Subsoiled	Wheat	1	20.2	10.5	8.7	0	10.6
Listed	do	1	24.5	7.8	8.0	0	12.3
Disked grain stubble	do	4	23.9	6.7	4.4	0	10.1
Disked corn stubble	Corn	12	23.6	9.7	8.6	0	14.5
Fallow	Fallow	10	27.5	20.0	10.1	2.9	19.3
Green manured	Winter rye	1	23.8	18.3	6.0	0	15.9
Do	Peas	1	26.0	14.2	8.0	0	17.9
Do	Sweetclover	1	22.2	13.2	10.5	0	14.2
Total or average		41	24.5	12.2	7.9	.7	[1] 14.8

[1] Because the number of plots was increased after the experiment was begun, the figure given is the average of the average yields obtained each year and not the average of the average yields shown for each method.

OATS

The Sixty-Day variety of oats has been used in these experiments since they were begun. The largest yields of this crop have usually been produced on summer-fallowed land, but in 1927—a season of very favorable growing conditions—the yields of oats on fallow were exceeded by the returns from several other cultural treatments. The highest average yield was produced by oats sown on disked cornland. In 1928 oat yields from all tillage methods except fall-plowed barley, fallow, sod, and green-manure treatments dropped below the average production since 1913. Yields were further diminished during the dry season of 1929, and in the third year of drought, 1930, oats were a total failure. The yields of oats in the experiments are shown in Table 23.

TABLE 23.—*Annual acre yields of oats from different methods of tillage and crop sequence at the Huntley field station, 1927–1930, and for the 18-year period 1913–1930*

Seed-bed preparation	Preceding crop	Plots averaged	Average acre yield				
			1927	1928	1929	1930	1913–1930
		Number	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*
Fall plowed	Wheat	6	49.8	26.0	17.2	0	26.9
Do	Barley	1	46.9	29.7	23.8	0	29.3
Do	Oats	1	45.9	16.9	14.1	0	23.1
Spring plowed	Corn	2	53.6	16.8	20.3	0	30.0
Do	Wheat	2	47.7	26.5	19.4	0	28.0
Do	Oats	1	46.6	15.0	10.9	0	23.4
Do	Flax	1	48.1	19.4	12.8	0	24.6
Subsoiled	Oats	1	51.6	21.9	10.3	0	22.3
Listed	do	1	55.3	20.9	7.8	0	27.7
Disked corn stubble	Corn	9	57.0	27.7	21.2	0	32.2
Fallow	Fallow	3	52.7	53.3	22.5	0	42.3
Green manured	Winter rye	2	53.3	49.9	13.9	0	35.8
Do	Peas	2	52.2	48.3	15.5	0	38.4
Do	Sweetclover	1	51.9	44.1	12.5	0	32.8
Sod crops	Alfalfa	1	42.8	37.2	14.1	0	25.4
Do	Bromegrass	1	41.9	32.5	12.8	0	25.8
Total or average		35	51.0	31.0	17.7	0	[1] 31.3

[1] Because the number of plots was increased after the experiment was begun, the figure given is the average of the average yields obtained each year and not the average of the average yields shown for each method.

BARLEY

Hannchen barley was sown on 11 plots in the tillage and rotation experiments during the four years under review. Notwithstanding the favorable season of 1927, barley yields, although higher than the average, were relatively lower than the returns of the other small-grain crops. Barley following winter rye that had been plowed under for green manure was the highest yielding plot. Barley grown on spring-plowed oats stubble ranked second, and that grown on summer fallow third. Barley on the winter-rye green manure again produced the maximum yield in 1928, and that on summer fallow the next largest yield. In 1929 all barley yields with one exception were extremely low, owing to drought and retarded spring growth. Barley on disked flax stubble produced an outstandingly high yield. The crop on this plot came up promptly in the spring and was more fully developed before being checked by drought than was barley on the seed beds prepared otherwise. Drought, high temperatures, and scarcity of available soil moisture combined to make growing conditions in 1930 very unfavorable for barley production. The crop on all plots dried up before reaching maturity, and no yields were obtained. The average yields in the barley experiments are given in Table 24.

TABLE 24.—*Annual acre yields of barley from different methods of tillage and crop sequence at the Huntley field station, 1927–1930, and for the 18-year period 1913–1930*

Seed-bed preparation	Preceding crop	Plots averaged	Average acre yield				
			1927	1928	1929	1930	1913–1930
		Number	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*
Fall plowed	Barley	1	19.2	3.1	1.7	0	9.0
Spring plowed	Oats	1	30.8	8.8	4.6	0	14.8
Do	Barley	1	23.3	2.1	.4	0	11.4
Disked flax stubble	Flax	1	23.8	17.5	24.0	0	17.1
Disked corn stubble	Corn	4	26.1	12.3	3.2	0	17.2
Fallow	Fallow	1	26.7	25.8	2.9	0	18.7
Green manured	Winter rye	1	32.1	31.7	3.3	0	21.1
Do	Peas	1	27.7	26.8	1.5	0	21.2
Total or average		11	26.2	14.4	4.6	0	[1] 17.6

[1] Because the number of plots was increased after the experiment was begun, the figure given is the average of the average yields obtained each year and not the average of the average yields shown for each method.

FLAX

The Linota variety of flax was used in the rotation and tillage experiments from 1927 to 1930. In 1927 yields above the average were produced on all plots. Flax grown on two plots of spring-plowed corn stubble returned the highest yield. The second highest yield was obtained from flax on fall-plowed cornland. The lowest yields were from the experiment in which flax was continuously cropped on the same land. In 1928 the yields dropped below those obtained in 1927, although the production from some of the tillage methods was still greater than the average. Flax following corn in a rotation or grown on fallow land again yielded well. The drought of 1929 was reflected in very low returns of flax, all methods producing less than average yields. The highest yield of the season was obtained on spring-plowed cornland. This was followed closely by flax on fallow and flax on disked cornland. No yields whatever were obtained in 1930, the crop having dried up before setting seed. In Table 25 are shown the average yields of flax obtained from the various crop sequences and cultural treatments.

TABLE 25.—*Annual acre yields of flax from different methods of tillage and crop sequence at the Huntley field station, 1927–1930, and for the 18-year period 1913–1930*

Seed-bed preparation	Preceding crop	Plots averaged	Average acre yield				
			1927	1928	1929	1930	1913–1930
		Number	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*
Fall plowed	Corn	1	15.6	7.0	4.5	0	7.6
Do	Flax	3	8.4	8.1	4.8	0	5.9
Spring plowed	Oats	1	12.9	4.6	3.6	0	6.1
Do	Wheat	1	15.5	8.6	3.6	0	7.5
Do	Corn	2	19.5	10.4	6.1	0	8.1
Do	Flax	2	9.5	2.7	3.3	0	5.9
Subsoiled	do	1	12.3	6.6	2.5	0	5.1
Listed	do	1	11.3	4.3	1.3	0	5.2
Disked corn stubble	Corn	2	15.1	5.0	5.9	0	7.2
Fallow	Fallow	2	11.6	10.7	5.0	0	9.2
Total or average		16	12.9	7.1	4.5	0	[1] 7.0

[1] Because the number of plots was increased after the experiment was begun, the figure given is the average of the average yields obtained each year and not the average of the average yields shown for each method.

CORN

Northwestern Dent has been the variety used in the corn experiments since 1912. In 1927 the yields of grain and stover were uniformly high. The maximum yield of grain was obtained from corn continuously cropped on fall-plowed and subsoiled land. Next in order were grain yields of corn following flax on spring plowing and after fall-plowed winter-wheat stubble. Taken as a whole, corn grown on fall-plowed land gave slightly higher yields of grain and stover than was obtained from corn on spring plowing.

The residual effects of the very favorable crop season of 1927 were demonstrated to some extent by the corn crop produced in 1928. Although all corn yields in 1928 were much below those obtained in 1927, there were a number of cultural treatments, notably among the fall-plowed group of plots, that returned yields above the average. The highest yield was from fallowed land.

Most grain yields of corn in 1929 were practically failures, although stover returns were in many cases above those obtained in 1928. In 1930 because of drought and very unfavorable growing conditions the crop failed to mature grain. The stover yields from all treatments were also very much below the average.

The average yields of corn and stover for the various rotation and tillage experiments are given in Table 26.

TABLE 26.—*Annual acre yields of corn from different methods of tillage and crop sequence at the Huntley field station, 1927–1930, and for the 18-year period 1913–1930*

Seed-bed preparation	Preceding crop	Plots averaged	Average acre yield									
			1927		1928		1929		1930		1913–1930	
			Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
		No.	*Bus.*	*Lbs.*	*Bus.*	*Lbs.*	*Bus.*	*Lbs.*	*Bus.*	*Lbs.*	*Bus.*	*Lbs.*
Fall plowed	Oats	4	46.4	3,550	9.3	683	0	1,043	0	280	16.0	1,564
Do	Spring wheat	2	46.0	3,900	14.6	825	.2	1,115	0	320	16.8	1,568
Do	Flax	1	46.9	4,480	22.6	1,700	5.2	1,310	0	370	16.5	2,159
Do	Winter wheat	1	52.5	4,060	23.2	1,300	6	910	0	610	22.9	2,456
Do	Corn	1	46.1	2,140	27.8	1,186	6.5	1,200	0	280	16.7	1,584
Spring plowed	Spring wheat	5	48.8	3,444	11.4	654	1.4	1,322	0	160	17.4	1,634
Do	Oats	13	42.9	3,708	11.7	708	1.2	1,224	0	287	17.4	1,774
Do	Winter wheat	6	42.4	2,283	11.3	497	1.1	960	0	268	16.3	1,533
Do	Barley	3	39.8	2,780	12.2	350	1.3	1,133	0	350	17.2	1,511
Do	Flax	3	52.9	5,030	9.4	807	1.1	1,190	0	260	16.6	1,091
Do	Corn	1	45.8	1,480	16.7	660	4.1	1,560	0	410	16.6	1,401
Subsoiled	do	1	53.2	2,110	29.4	1,420	3.7	1,340	0	300	17.2	1,761
Listed	do	1	45.3	1,700	20.0	1,300	4.5	1,000	0	610	22.4	1,404
Fallow	Fallow	1	44.3	1,980	31.8	1,520	4.8	1,740	0	960	25.5	2,253
Total or average		43	45.2	3,328	13.5	753	1.5	1,170	0	309	[1]17.0	[1]1,706

[1] Because the number of plots was increased after the experiment was begun, the figure given is the average of the average yields obtained each year and not the average of the average yields shown for each method.

VARIETY TESTS

WINTER WHEAT

Ten varieties and selections of winter wheat have been grown in comparison with one another during the four years covered by this report. These trials were conducted on replicated plots as well as in nursery rows each year except 1930, when plots alone were used. Favorable growing conditions in 1927 resulted in yields of all varieties

well above the average. In 1928 good stands and yields were obtained from the winter wheat grown on plots, but in the rod-row tests poor stands were responsible for yields below the average. The stands of all varieties were uniformly thin in plot and row plantings in 1929, but most of the wheats grown on the plots yielded above the average for the varieties, whereas the production from the rows was less than average. In 1930, because of poor stands and a dry season, the winter-wheat varieties, all of which were grown on plots, made comparatively poor returns. Not only were the yields low, but the quality of the wheat was much below the average. The winter-wheat variety test is summarized in Table 27.

TABLE 27.—*Annual and average acre yields of winter wheat (bushels) grown on dry land in replicated nursery rows and plots in variety tests, at the Huntley field station, 1927–1930*

Variety	1927		1928		1929		1930	Average	
	Plots	Rows	Plots	Rows	Plots	Rows	Plots	1928–1930 plots	1927–1929 rows
Kharkof	40.7	44.4	34.0	27.3	31.7	22.7	8.6	25.1	31.5
Turkey	(1)	43.5	31.5	15.6	33.3	25.5	10.8	25.2	28.2
Montana 36	(1)	38.8	35.5	18.4	28.0	26.5	10.0	24.5	27.9
Kanred	36.3	41.6	35.4	13.8	28.5	22.7	9.7	24.5	26.0
Newturk	(1)	34.0	34.5	15.9	30.5	26.5	10.9	25.3	25.5
Karmont	38.7	38.8	23.9	13.1	25.2	22.7	8.3	19.1	24.9
Alton	38.3	40.6	35.5	12.3	26.2	20.8	7.8	23.2	24.6
Ridit	(1)	34.1	27.0	10.8	27.2	13.2	9.4	21.2	22.4
Hybrid 128	(1)	31.2	33.3	14.3	22.9	21.8	(1)	[2] 28.1	22.4
Burbank Super	(1)	35.0	30.3	13.5	23.5	18.0	(1)	[2] 26.9	22.2

[1] Variety not planted. [2] Average 1928 and 1929.

SPRING WHEAT

There has been no consistency in the number or varieties of spring wheat grown for comparison during the four years. Since 1929 this line of work has been conducted in cooperation with the Division of Cereal Crops and Diseases of the Bureau of Plant Industry. That division supplied seed of 11 of the varieties used in 1929 and 1930. The yields of the spring-wheat varieties grown in 1927 were uniformly good, owing to the favorable season, but the returns of most varieties in the three years following were less each season than those of the previous year. The annual and average yields are given in Table 28.

TABLE 28.—*Annual and average acre yields of spring wheat (bushels) grown on dry land in variety tests at the Huntley field station, 1927–1930*

Variety	1927	1928	1929	1930	Average	
					1927–1930	1929–1930
Hard Federation	30.0	13.7	10.3	(1)		
Reward	(1)	(1)	10.8	4.5		7.7
Kota	24.8	13.9	7.5	(1)		
Peliss	27.3	14.4	6.5	(1)		
Marquis	20.5	13.2	6.8	6.1	13.7	6.0
Acme	25.2	19.7	6.7	4.3	14.0	5.5
Kubanka	28.7	11.4	3.5	7.3	12.7	5.4
Ceres	(1)	(1)	7.2	3.6		5.4
Supreme	24.6	8.0	7.0	3.5	10.8	5.3
Hope	(1)	(1)	6.0	4.3		5.2
Nodak	(1)	(1)	4.0	5.8		4.9
Federation	(1)	(1)	7.3	2.3		4.8
Mindum	(1)	(1)	7.0	2.5		4.8
Reliance	(1)	(1)	5.0	4.5		4.8
Marquillo	(1)	(1)	5.8	2.5		4.2
Champlain (Pringle Champlain)	16.9	19.5	4.0	4.0	11.1	4.0

[1] Variety not planted.

OATS

Several varieties of oats have been tried from time to time on the dry-land plots, but during the period 1927 to 1930 only four varieties were grown consistently for three or more years. The range in oat yields during these four years has corresponded closely with that of other small-grain crops. The unusually heavy production of all varieties in 1927 was followed by diminished yields in the succeeding seasons until 1930, when the oat crop was a complete failure owing to the extremely unfavorable growing conditions. Table 29 gives the yields of four varieties grown during the 4-year period.

TABLE 29.—*Annual and average acre yields of oats (bushels) grown on dry land in variety tests at the Huntley field station, 1927–1930*

Variety	1927	1928	1929	1930	Average
Markton	105.0	49.3	34.6	0	47.2
Victory	97.8	51.1	30.5	0	44.9
Sixty-Day	76.6	41.6	32.0	0	37.6
Gopher	(1)	55.8	33.6	0	20.8

[1] Variety not grown.

BARLEY

Data on the growth and yield of six varieties of barley have been obtained each year of the period under review. All varieties yielded extremely well in 1927, but in the succeeding years the returns were less than the average. In fact, the drought in 1930 was so severe that all of the barley plantings dried up before maturity, and no yields were obtained. Table 30 presents the average annual yields of barley in these tests.

TABLE 30.—*Annual and average acre yields of barley (bushels) grown on dry land in variety tests at the Huntley field station, 1927–1930*

Variety	1927	1928	1929	1930	Average
Trebi	55.8	10.2	19.4	0	21.4
White Smyrna	50.4	0.6	16.9	0	18.5
Horn	47.9	7.6	15.5	0	17.8
Himalaya	51.0	5.8	10.6	0	16.9
Hannchen	45.2	5.9	2.9	0	13.5
Success	33.8	0.1	7.9	0	12.7

CORN

The object of the variety tests of corn has been to find a variety that will thrive under dry-land conditions and mature a relatively high yield of grain and stover in an average frost-free period of 127 days and that will be adaptable to harvesting by machinery or by livestock. With this in view, a large number of corn varieties and strains have been tried at the Huntley station since 1915. A number of the first varieties to be grown have been discarded as undesirable or have been supplanted by superior strains. Beginning in 1922 a group of varieties was selected for continued trial, this group to be further reduced or enlarged as warranted by the results obtained.

Table 31 presents the yields of grain from 10 varieties of corn, all but 1 of which have been planted each year since 1922. Five of these varieties have matured grain every year except 1925, 1926, 1929, and 1930, during which years the crop was killed by drought. Of these

five varieties, Northwestern Dent, Falconer, and Minnesota 23 may be harvested by machinery or by livestock, whereas Dakota White Flint and Gehu Flint are suitable for harvesting by livestock only. Payne White Dent was slightly immature in two of the five years that corn was produced, and the late varieties, including Calico, Golden Glow, Minnesota 13, and Rainbow Flint, have frequently failed to mature grain before frost. The late varieties, however, usually have developed grain to the stage where the crop may be used for silage or pasturage, and as the fodder yields of the late types are generally heavy, they may profitably be grown for the purposes suggested.

TABLE 31.—*Annual and average acre yields of corn (bushels) grown on dry land in variety tests at the Huntley field station, 1922–1930*

Variety	1922	1923	1924	1925	1926	1927	1928	1929	1930	Average
Falconer	26.5	27.1	25.8	0	0	52.4	19.2	0	0	16.8
Northwestern Dent	24.8	18.3	37.0	0	0	45.2	14.8	0	0	15.6
Dakota White Flint	22.3	20.1	26.7	0	0	42.9	17.0	0	0	14.3
Minnesota 23	28.7	17.7	29.7	0	0	37.2	14.3	0	0	14.2
Gehu Flint			31.6	0	0	39.5	20.4	0	0	13.1
Payne White Dent	24.5	[1] 28.9	33.5	0	0	[1] 44.8	14.3	0	0	16.2
Golden Glow	21.9	[1] 35.8	[2] 35.9	0	0	[1] 43.6	[1] 6.9	0	0	16.0
Minnesota 13	18.1	[1] 29.9	[2] 29.4	0	0	41.0	[1] 6.9	0	0	13.9
Calico Dent	[1] 17.2	[1] 45.8	[2] 39.0	0	0	[2] 41.8	[1] 4.3	0	0	16.5
Rainbow Flint	[1] 14.8	[2] 63.9	[2] 50.5	0	0	[2] 40.1	[1] 5.8	0	0	19.5

[1] Slightly immature. [2] Very immature.

POTATOES

Variety testing with potatoes has been conducted on dry land at the Huntley station since 1915. During that period a total of 23 varieties and strains have been tried for varying periods of time. Of the varieties used, Bliss Triumph has been planted every year and Rural New Yorker in 15 of the 16 years of testing. Three other varieties—Irish Cobbler, Early Ohio, and Russet Burbank—have been grown for 14 years each, although the years in which they were planted were not consecutive. No marketable potatoes were harvested from any of the varieties in 1919, 1929, or 1930, as the growth of the crop was checked by drought before the tubers attained a commercial size. The yields of eight varieties of potatoes grown in this test for nine or more years are given in Table 32.

TABLE 32.—*Average annual acre yields of potatoes (bushels) grown on dry land in variety tests at the Huntley field station, 1927–1930, and average yields for the periods 1915–1930 and 1927–1930*

Variety	Acre yield (bushels)				Average			
					1915–1930		1927–1930	
	1927	1928	1929	1930	Years grown	Yield per acre	Years grown	Yield per acre
					Number	*Bushels*	*Number*	*Bushels*
Green Mountain	[1]	[1]	[1]	[1]	11	96.1	0	[1]
Early Eureka	165.6	66.0	[2]	[2]	12	82.3	4	57.9
Irish Cobbler	[1]	70.5	[2]	[2]	14	77.9	3	
White Ohio	194.3	70.8	[2]	[2]	9	76.7	4	66.3
Rural New Yorker	192.5	30.9	[2]	[2]	15	75.0	4	55.9
Early Ohio	172.7	74.1	[2]	[2]	14	71.5	4	61.7
Bliss Triumph	183.8	62.7	[2]	[2]	16	61.6	4	61.6
Russet Burbank	133.9	25.5	[2]	[2]	14	60.0	4	39.9

[1] Variety not planted. [2] As a result of drought no marketable potatoes were produced.

ROW-SPACING TEST WITH FIELD BEANS

An experiment to determine the yields of field beans planted in rows 24, 30, and 36 inches apart was begun in 1918. The Early Navy variety was tried in this test from 1918 to 1923, inclusive, and from 1924 to 1930 the Great Northern variety, the bean commonly grown in this locality, was used. Prior to 1924 the beans planted in rows 30 inches apart consistently returned higher yields than did the 24-inch and 36-inch spacings. Great Northern beans planted in rows 36 inches apart have outyielded beans grown in rows 24 and 30 inches apart in three years out of four in which crops have been produced since 1924. The average yields for the 30-inch spacings are, however, a little larger than those obtained from the 24-inch and 36-inch plantings over the 1918–1930 period and also the 1927–1930 period, as shown in Table 33.

TABLE 33.—*Annual average acre yield of field beans (pounds) planted on dry land in row-spacing tests at the Huntley field station, 1927–1930, and averages for the periods 1918–1930 and 1927–1930*

Distance between rows	1927	1928	1929	1930	Average	
					1918–1930	1927–1930
24 inches	1,540	182	0	0	405	431
30 inches	1,550	238	0	0	435	447
36 inches	1,560	220	0	0	408	445

PASTURING DRY-LAND CROPS BY HOGS

The experiments in pasturing dry-land crops by hogs were begun in 1915, for the purpose of determining (1) the suitability of various grain and forage crops for hog pasture, (2) the possibility of arranging a series of crops for the production of palatable forage throughout the season, (3) the agronomic effect on succeeding crops of manure resulting from pasturing, and (4) the economic merits of pasturing hogs on the crops as compared with harvesting them with machinery in the ordinary manner. Both annual and perennial crops were used.

ANNUAL-CROP PASTURES

Prior to 1924 the annual crops used were winter rye, field peas, beardless barley, and corn. These crops were grown in a rotation and were pastured in the order named. The first three crops were grazed by fall pigs, and the corn was harvested by spring pigs. Crops on a duplicate rotation adjacent to the pasture experiment were harvested by machinery and the yields determined. Not only did the duplicate unpastured rotation provide information on the seasonal growth of the varieties of crops pastured, but by comparing the returns from the pastured and the harvested rotations it is possible to determine which method of handling the crops would prove most profitable over a series of years.

Beginning with 1924, spring pigs were used to pasture the annual crops. Mature barley having proved to be unsuitable for "hogging off" under the conditions of the experiment, the pasturing of that crop was discontinued in 1924, and the plot of barley in the pasture rotation has since been harvested by machinery and threshed each year.

By comparing the yields of barley from the pastured and unpastured rotations the cumulative agronomic effects of pasturing may be measured. In place of the barley pasture, the spring pigs were provided with combination crop pastures consisting of Sudan grass and soybeans, and sorgo and soybeans, which were used to fill the grazing interval between field peas and corn. On all pastures except corn the spring pigs were provided with a supplementary ration of self-fed corn, and skim milk was also fed when available. Throughout the pasture season a similar lot of spring pigs was fed a full ration of shelled corn and skim milk in a dry pen without pasture. The dry-pen pigs were used as a check lot by which the growth of the pigs on pasture was measured and the economy of gains determined. The results obtained in the pasturing experiments vary widely from year to year, owing primarily to the type of season, which may affect the quantity, palatability, and period of production of the forage and consequently the growth made by the hogs.

In 1927, a year of comparatively heavy seasonal rainfall, all crops used for pasturage produced an abundance of forage. Two mature sows and 15 spring pigs were placed on the acre plot of winter rye in the pasture rotation on May 18, when the crop was about 15 inches tall. At that stage the crop was too far advanced and grew too rapidly to be kept pastured off by the pigs, and it was necessary to mow the rye to promote new growth and prevent seed formation. The mowing was done June 10, and conditions were such that a new and more palatable growth started soon afterwards.

On that date also the pigs were weaned and the sows removed from the pasture. The pasture period on rye was terminated July 8. Because of the extremely succulent quality of the forage the gains made by the pigs were low. The supplementary grain consumed was above the average. From the standpoint of grain consumed the pigs in the check lot produced more economical gains than did the pigs on pasture.

In each of the years 1928, 1929, and 1930, precipitation was light and the amount of forage produced was much less than in 1927. In addition to the 15 spring pigs used each year, 2 brood sows were carried on the rye pasture for a period of 28 days in 1929 and 26 days in 1930. The average daily gains made by the pigs on rye pasture were higher in 1928, 1929, and 1930 than in 1927. Also the amount of supplementing grain fed for each 100 pounds of gain was less during the last three years than in 1927, but the pasture pigs each year consumed more grain per unit of gain than did the pigs in the check lot.

Table 34 presents the data obtained in the rye-pasturing experiment.

TABLE 34.—*Results obtained from pasturing winter rye (1-acre plots) by spring pigs at the Huntley field station, 1927–1930*

Items of comparison	1927	1928	1929	1930
Test begun	May 18	May 14	May 9	May 3
Test closed	July 8	June 26	July 5	June 19
Length of test—days	51	43	57	47
Pigs pastured—number	15	15	15	15
Average initial weight—pounds	21.8	32.0	23.9	19.6
Average final weight—do	45.9	66.1	74.3	50.6
Average gain—do	24.1	34.1	50.4	31.0
Average daily gain—do	.47	.79	.88	.60
Total gain of pigs—do	362	512	755	465
Weight lost by brood sows—do	98	----------	123	93
Net gain of pigs [1]—do	264	512	632	372
Total feed consumed [2]—do	1,194	2,247	2,409	1,483
Feed per 100 pounds of gain:				
Pasture lot—do	452	439	381	399
Check lot [3]—do	372	319	375	332
Corn replaced by 1 acre of pasture—do	[4]—211	[4]—614	[4]—38	[4]—249
Acre yield of check plots—bushels	17.4	12.3	9.3	.4

[1] Gain of pigs minus loss of sows.
[2] Corn, self-fed; skim milk, hand fed; total calculated on the basis of 4 pounds of milk equaling 1 pound of corn.
[3] The check lot fed in a dry pen without pasture consisted of 11 pigs in 1927, 10 pigs in 1928, 14 pigs in 1929, and 17 pigs in 1930.
[4] Minus indicates loss.

Each year the pigs have been moved to the acre plot of field peas on the date of closing the pasture period on winter rye. The character of this forage at the time of pasturing varies greatly with the type of season and the length of rye-pasture period. In some years the peas have begun to form seed before the plot was opened for pasturing, while in other seasons it has been necessary to use the plot of peas at an earlier stage of growth in order to provide the pigs with continuous grazing. In 1927 the peas produced a heavy growth of vines and had begun to form seed when the plot was opened to grazing. The gains in weight made by the pigs, though small, were economical when based on the grain consumed. The seasons of 1928, 1929, and 1930 were dry, and the pea forage was not as plentiful as in 1927. In fact, in 1930 the peas dried up before making enough growth to warrant pasturing, and the experiment was omitted for the season. The gains in 1928 and 1929 were somewhat higher than those in 1927. Grain consumed per unit of gain was also higher than in 1927, but less grain was used by the pigs on pasture than by those in the check lot to produce a hundredweight of gain. The data from pasturing peas are summarized in Table 35.

TABLE 35.—*Results obtained from pasturing field peas (1-acre plots) by spring pigs at the Huntley field station, 1927–1930*

Items of comparison	1927	1928	1929	1930
Test begun	July 8	June 26	July 5	(1)
Test closed	Aug. 5	Aug. 2	Aug. 1	----------
Length of test—days	28	37	27	----------
Pigs pastured—number	15	15	15	----------
Average initial weight—pounds	45.9	66.1	70.2	----------
Average final weight—do	62.7	106.5	104.0	----------
Average gain—do	16.8	40.4	33.8	----------
Average daily gain—do	.60	1.09	1.25	----------
Total gain of pigs—do	252	606	507	----------
Total feed consumed—do	720	1,964	1,575	----------
Feed per 100 pounds of gain:				
Pasture lot—do	286	324	311	----------
Check lot—do	395	331	354	----------
Corn replaced by 1 acre of pasture—do	275	42	218	----------
Acre yields of check plot—bushels	10.8	8.0	0	0

[1] Field peas dried up before making sufficient growth for pasturage.

As a substitute for pea pasture in 1930 the pigs were given the run of one-half acre of alfalfa planted in rows 2 feet apart. They remained on the alfalfa for 42 days, June 19 to July 31, during which time they made an average daily gain of 1.25 pounds each. The shelled corn was equivalent to 254 pounds of grain for each 100 pounds of gain. The check lot of pigs during the same interval gained at the rate of 0.88 pound each per day and required 345 pounds of grain for a hundredweight of gain. The alfalfa pasture had a calculated grain-replacement value of 719 pounds to the acre for the 42-day period.

With the completion of the pasture period on field peas, the practice since 1924 has been to move the spring pigs from the acre of peas first to a combination pasture of Sudan grass and soybeans, one-fourth acre of each, and later to a combination pasture of sorgo and soybeans. The supplementary ration of self-fed shelled corn was continued on these combination pastures. With the exception of 1928, the pigs on Sudan grass-soybean pasture consumed more grain per 100 pounds of gain each year than did the pigs in the check lot. While on sorgo-soybean pasture, however, the pigs, except in 1927, required less grain for each hundredweight of gain than did the check-lot pigs. The data obtained from pasturing pigs on Sudan grass, soybeans, and sorgo are given in Table 36.

TABLE 36.—*Results obtained from grazing Sudan grass-soybeans and sorgo-soybeans mixed pastures (½-acre plots) by spring pigs at the Huntley field station, 1927–1930*

Items of comparison	Sudan grass, soybeans				Sorgo, soybeans		
	1927	1928	1929	1930 [1]	1927	1928	1929
Test begun	Aug. 5	Aug. 2	Aug. 1	July 31	Sept. 2	Aug. 21	Aug. 20
Test closed	Sept. 2	Aug. 21	Aug. 20	Sept. 11	Sept. 16	Sept. 11	Sept. 9
Length of test—days	28	19	19	42	14	21	20
Pigs pastured—number	15	15	15	13	15	15	[2] 15
Average initial weight—pounds	62.7	106.5	104.0	100.8	94.0	130.7	124.0
Average final weight—do	94.0	130.7	124.0	153.5	113.8	160.1	152.4
Average gain—do	31.3	24.2	20.0	52.8	19.8	29.4	28.8
Average daily gain—do	1.12	1.27	1.05	1.26	1.41	1.40	1.45
Total gain of pigs—do	469	363	300	686	297	441	420
Total feed consumed—do	1,471	1,117	1,423	2,880	1,122	1,784	1,463
Feed per 100 pounds of gain:							
Pasture lot—pounds	314	308	474	420	378	405	348
Check lot—do	310	400	357	407	390	434	402
Corn replaced by 1 acre of pasture—pounds	−38	668	−702	−89	−249	256	454
Acre yields [3] of check plots:							
Sudan grass—pounds	4,800	1,104	1,350	620			
Soybeans—do	13,870	712	1,250	0			
Sorgo—do					12,190	1,812	4,150
Soybeans—do					13,870	712	2,750

[1] Because of drought and the poor quality of the forage in 1930 the 2 pastures were grazed as 1 plot rather than separately, as was done in 1927, 1928, and 1929. The combined results from grazing the Sudan grass-soybean pasture and the sorgo-soybean pasture are given in this column.
[2] Only 14 pigs after September 2. Gains and feed of 15th pig included to nearest weighing date, Aug. 29.
[3] Air dry.

From the sorgo-soybean pasture the spring pigs have been taken to a 1-acre plot of Northwestern Dent corn in the pasture rotation. At that date the corn has usually been mature or nearly so, and no grain supplement has been fed with it. In some seasons, however, the pigs have had access to alfalfa hay or skim milk to balance the ration while on corn. The length of the pasture period on corn has varied greatly, depending upon the amount produced. In 1930, because of drought, no corn was produced, and that phase of the experiment was omitted. Small crops of corn were produced in 1928 and 1929, and the pasture

periods for those years were 7 days and 3 days, respectively; whereas in 1927 sufficient corn was produced to supply the pigs for 28 days. If the amount of grain consumed by the pigs on the pastured corn plot is calculated on the basis of the yields of corn from the check plot, the hogs in the dry pen have required less corn to produce a hundred pounds of gain than have the hogs on corn pasture. A summary of the corn-pasturing experiments is presented in Table 37.

TABLE 37.—*Results obtained from harvesting corn (1-acre plots) by spring pigs at the Huntley field station, 1927–1930*

Items of comparison	1927	1928	1929	1930 [1]
Test begun	Sept. 16	Sept. 11	Sept. 9	
Test closed	Oct. 14	Sept. 18	Sept. 12	
Length of test—days	28	7	3	
Pigs pastured—number	15	15	15	
Average initial weight—pounds	113.3	160.1	152.4	
Average final weight—do	152.0	163.9	147.8	
Average gain—do	38.2	3.8	−4.6	
Average daily gain—do	1.36	.54	−1.53	
Total gain of pigs—do	573	57	−69	
Total feed consumed [2]—do	2,744	680	258	
Feed consumed per 100 pounds of gain:				
Pasture lot—pounds	479	1,193		
Check lot—do	457	359	243	
Acre yields of check plots—bushels	49.0	11.2	3.6	0

[1] Corn dried up before producing grain, and the plot was not harvested by pigs.
[2] Feed consumed based on yield of check plot in 1927. In 1928 the corn was supplemented with skim milk, and the total feed was calculated from the yield of corn on the check plot plus the skim milk fed (4 pounds of milk equal to 1 pound of corn).

Plots of Success barley 1 acre in area were grown and harvested in both the pastured and unpastured rotations each year of the four here reviewed. The grain yields of barley from the pastured rotation exceeded those of the unpastured rotation in 1928 and 1929. Heavier yields of straw were obtained from the pastured than from the unpastured rotation in 1927 and 1928. No grain or straw was produced on either plot in 1930. The yield data from both plots are compared in Table 38.

TABLE 38.—*Annual acre yields of barley straw and grain obtained from plots in similar rotations in one of which all crops but barley were pastured by hogs and in the other all crops were harvested by machinery, at the Huntley field station, 1927–1930*

Rotation treatment	1927		1928		1929		1930	
	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain
	Pounds	*Bushels*	*Pounds*	*Bushels*	*Pounds*	*Bushels*	*Pounds*	*Bushels*
Pastured	2,810	20.4	776	21.1	1,099	15.6	0	0
Harvested	2,800	33.8	323	0.1	1,160	10.9	0	0

PERENNIAL-CROP PASTURES

The perennial crops have been represented in the dry-land pasturing experiments by two plots each of alfalfa and bromegrass. One plot of each crop has been grown in rows 2 feet apart, and the other has been close-seeded in drills 6 inches apart. During the years covered by this report ½-acre plots of each crop and seeding method were pastured by fall pigs, which, in addition to the forage, were hand-fed a daily ration of shelled corn equal to 3 per cent of the live weights of the animals. Throughout the period that the pigs were on pasture a check lot of similar pigs was given a ration of skim milk and self-fed

corn in a dry pen without pasture. The length of time the hogs remained on pasture each year was governed by the growth of the animals as well as by the condition of the forage, the object being to keep the hogs on pasture if possible until they had reached a marketable weight of 200 pounds or more. The highest average daily gains made by any of the fall pigs on perennial pastures were on row alfalfa and close-drilled alfalfa in 1928. The hogs have usually made more rapid gains on alfalfa pasture than on bromegrass; and from the viewpoint of supplementary grain consumed, the alfalfa pastures have also been the most economical. With one exception, from 1927 to 1930, the hogs on pasture have required less supplementary grain to produce 100 pounds of gain than have the hogs in the check lot. The results obtained by pasturing alfalfa and bromegrass by fall pigs are given in Tables 39 and 40.

TABLE 39.—*Results obtained from pasturing by fall pigs ½-acre plots of alfalfa sown in rows 2 feet apart and of alfalfa close-drilled, at the Huntley field station, 1927–1930*

Items of comparison	Alfalfa in rows				Alfalfa close-drilled			
	1927	1928	1929	1930	1927	1928	1929	1930
Test begun	May 7	May 14	May 17	May 16	May 7	May 14	May 17	May 16
Test closed	July 8	June 26	July 5	June 18	July 8	June 26	July 5	June 18
Length of test—days	62	43	49	33	62	43	49	33
Pigs pastured—number	3	3	3	3	3	3	3	3
Average initial weight—pounds	132.0	139.0	152.7	162.7	132.3	138.0	142.7	161.0
Average final weight—pounds	225.0	210.3	221.0	215.0	228.0	209.0	217.3	206.7
Average gain—do	93.0	71.3	68.3	52.3	95.7	71.0	74.6	45.7
Average daily gain—pounds	1.50	1.66	1.39	1.58	1.54	1.65	1.52	1.38
Total gain—do	280	214	205	157	287	213	224	137
Total feed consumed—pounds	988	700	843	547	1,002	700	828	527
Feed per 100 pounds of gain:								
Pasture lot—pounds	353	327	411	348	349	329	370	385
Check lot—do	398	428	451	538	398	428	451	538
Corn replaced by 1 acre of pasture—pounds	252	454	164	597	230	422	303	419

TABLE 40.—*Results obtained from pasturing by fall pigs ½-acre plots of bromegrass sown in rows 2 feet apart and of bromegrass close-drilled, at the Huntley field station, 1927–1930*

Items of comparison	Bromegrass in rows				Bromegrass close-drilled			
	1927	1928	1929	1930	1927	1928	1929	1930
Test begun	May 7	May 14	May 17	May 16	May 7	May 14	May 17	May 16
Test closed	July 8	June 26	July 5	June 18	July 8	June 26	July 5	June 18
Length of test—days	62	43	49	33	62	43	49	33
Pigs pastured—number	3	3	3	3	3	3	3	3
Average initial weight—pounds	132.0	139.3	150.3	159.3	131.7	138.7	151.0	158.0
Average final weight—pounds	209.3	192.7	221.7	205.3	213.3	193.7	221.3	199.7
Average gain—do	77.3	53.4	71.4	46.0	81.6	55.0	70.3	41.7
Average daily gain—pounds	1.25	1.24	1.46	1.39	1.32	1.28	1.43	1.26
Total gain—do	232	160	214	138	245	165	211	125
Total feed consumed—pounds	960	658	843	527	960	672	843	527
Feed per 100 pounds of gain:								
Pasture lot—pounds	414	411	394	382	392	407	400	422
Check lot—do	398	428	451	538	398	428	451	538
Corn replaced by 1 acre of pasture—pounds	−74.6	54.0	244	431	29.0	69.0	215	290

EXPERIMENTS WITH DAIRY CATTLE[6]

A herd of registered Holstein-Friesian cattle is maintained by the Bureau of Dairy Industry at the Huntley field station, and cooperative experiments are carried on in breeding and feeding dairy cows and in grazing irrigated pastures. Feeding tests comparing the economy of production have been completed in which groups of cows were fed rations consisting of roughage alone, roughage and a full feed of grain, and roughage and a limited amount of grain. An experiment was conducted to determine the adaptability of alfalfa for silage. Experiments to determine the effect of alfalfa hay as a complete ration for dairy cows are being carried on. Experiments in grazing irrigated pastures have included tests of the carrying capacity of various pasture-grass mixtures and sweetclover. The effect of top-dressing pastures with manures and phosphates is being studied. The breeding experiments deal largely with establishing a strain of cattle pure in their inheritance for high milk and butterfat production. This is to be accomplished through the continued use of proved sires, i. e., sires that are known to transmit high production to their offspring. Dairymen in the neighborhood of the station cooperate in proving these sires by using them in their herds and by keeping production records of their cows and the daughters of these sires.

PROVED-SIRE TESTS

The proving of sires was started in 1918, and during the period 1918 to 1930 a total of 73 sires were placed for proving. This total includes the sires used at the station as well as those placed in cooperators' herds throughout the States of Montana and Wyoming. At the time of writing this report 38 sires were being proved by 67 cooperators in the country adjacent to the station. Several sires have been proved during the last few years and have gone to head herds in other experiment stations or colleges where the proved-sire experiment is being carried on. The men using these sires agree to retain the heifers sired by the bulls and to furnish production records of the dams as well as of the heifers. During 1930 a total of 1,127 cows were tested for milk and butterfat production, each cow's record being kept on file and a written report sent to each cooperator. Up to the end of 1930 a total of 1,360 heifers had been sired by station bulls. Of this number, 1,109 are still living or have made records in present cooperators' herds or those of former cooperators.

Table 41 contains a comparison of the records of 302 daughters sired by 31 station bulls in cooperators' herds, with records of the dams of those daughters. The list of sires includes all bulls having two or more first-generation daughters that have completed at least 1-year's lactation period. Of the daughters, 232 exceeded the production of their dams in milk, 161 in percentage of butterfat, and 240 in total amount of butterfat.

[6] Report prepared by D. V. Kopland. The dairy work is conducted under the supervision of the Division of Dairy Cattle Breeding, Feeding, and Management, Bureau of Dairy Industry.

TABLE 41.—*Records of first-generation daughters of bulls having two or more such daughters with records, compared with the records of the dams of those daughters*

[All records calculated to a mature basis]

Sire No.	Daughters					Dams					Increase or decrease		
	Cows	Records	Milk	Butterfat		Cows	Records	Milk	Butterfat		Milk	Butterfat	
	Number	Number	Pounds	P. ct.	Pounds	Number	Number	Pounds	P. ct.	Pounds	Pounds	P. ct.	Pounds
H–104	[1] 22	25	16,351.2	3.55	581.19	[1] 22	37	15,330.8	3.44	527.38	1,020.4	0.11	53.81
H–105	13	19	10,265.8	3.67	377.08	13	32	10,030.1	3.64	365.19	235.7	.03	11.89
H–107	20	37	11,291.9	3.81	430.70	20	47	9,154.9	3.71	338.90	2,137.0	.10	91.80
H–109	12	28	10,372.1	3.64	377.60	12	15	6,870.6	3.81	261.82	3,501.5	−.17	115.78
H–111	13	18	9,804.9	3.55	348.19	13	35	8,049.9	3.46	278.30	1,755.0	.09	69.89
H–112	27	54	12,129.9	3.64	441.76	27	62	9,047.0	3.68	333.77	3,082.9	−.04	107.99
H–113	3	7	10,818.9	3.48	376.24	3	14	9,834.8	3.38	332.74	984.1	.10	43.50
H–114	8	10	8,410.5	3.90	328.09	8	22	7,365.9	3.64	268.71	1,044.6	.26	59.38
H–115	14	17	11,275.3	3.54	399.48	14	42	8,689.3	3.56	309.36	2,586.0	−.02	90.12
H–116	3	3	9,978.0	3.76	375.22	3	8	7,811.8	3.54	277.66	2,166.2	.22	97.56
H–117	7	9	8,956.6	3.79	339.65	7	24	10,778.4	3.55	384.48	−1,821.8	.24	−44.83
H–118	9	12	11,298.7	3.63	410.74	9	14	9,398.2	3.60	347.56	1,900.5	−.06	63.18
H–120	10	23	11,680.3	3.45	403.76	10	23	8,403.4	3.59	301.84	3,276.9	−.14	101.92
H–121	4	7	14,598.6	3.58	524.96	4	13	12,633.4	3.63	459.50	1,965.2	−.05	65.46
H–123	12	20	9,467.9	3.48	329.58	12	21	7,206.2	3.36	242.41	2,261.7	.12	87.17
H–126	10	13	10,434.5	3.70	386.13	10	32	9,804.5	3.65	357.76	630.0	.05	28.37
H–127	9	11	9,623.6	3.53	340.42	9	19	7,400.2	3.70	273.92	2,223.4	−.17	66.50
H–130	5	5	10,413.2	3.57	372.28	5	9	8,324.0	3.88	323.68	2,088.6	−.31	48.60
H–131	6	7	9,322.7	3.80	354.55	6	12	7,636.3	3.59	274.11	1,686.4	.21	80.44
H–132	3	3	14,957.0	3.70	554.46	3	6	11,482.4	3.57	409.21	3,494.6	.13	145.25
H–135	3	3	11,549.1	3.48	402.11	3	5	10,406.8	3.39	353.66	1,142.3	.09	48.45
H–143	4	4	12,310.4	3.53	434.62	4	9	9,713.7	3.47	337.18	2,596.7	.06	97.44
H–257	19	31	10,334.0	3.50	361.38	19	47	8,601.9	3.49	299.83	1,732.1	.01	61.54
A–104	3	3	10,730.3	3.50	375.92	3	10	8,739.8	3.78	330.34	1,990.5	−.28	45.58
A–105	[1] 23	36	14,138.9	3.61	511.03	[1] 23	55	13,543.4	3.53	478.27	595.5	.08	32.76
A–107	15	26	9,734.3	3.69	359.59	15	42	8,542.0	3.67	313.64	1,192.3	.02	45.95
A–108	7	24	8,900.9	3.38	302.27	7	17	9,800.6	3.13	306.78	−899.7	.25	−4.51
A–109	11	26	9,911.3	3.47	344.37	11	25	9,230.2	3.44	317.66	681.1	.03	26.71
A–110	2	2	12,381.0	3.57	442.49	2	4	9,127.1	3.78	345.55	3,253.9	−.21	96.95
A–119	2	4	10,984.0	3.91	430.23	2	4	8,622.3	3.27	282.01	2,361.7	.64	148.22
A–121	3	3	11,787.3	3.48	411.27	3	3	8,193.3	3.81	312.50	3,594.0	−.33	98.77
Average	9.7	15.8	11,398.0	3.61	411.17	9.7	22.8	9,594.4	3.57	342.44	1,757.0	.04	67.15

[1] Official records made in the Huntley station herd.

Six of the bulls in the comparison (A–107, A–108, A–109, A–110, A–119, and A–121) were sired by the bull Colantha Pontiac Hero. These bulls had a total of 40 daughters with completed records, which, when compared with those of their dams, show increases of 19.02 per cent in milk, 2.28 per cent in percentage of butterfat, and 21.94 per cent in pounds of butterfat. Only one of these six sons shows a loss in transmitting milk-producing ability, comparing the total records of the daughters with their dams.

Five of the bulls (H–130, H–131, H–132, H–135, and H–141) were sired by Friend Ona Hartog Korndyke (A–105) and have a total of 21 daughters with completed records which show, in comparison with those of their dams, increases of 23.15 per cent in milk, 1.40 per cent in butterfat test, and 24.74 per cent in pounds of butterfat. Not one of these five sires shows an individual decrease in total milk and fat production of his daughters. In most instances the daughters of these bulls are from dams whose sires were by a station bull.

The daughters of all but 1 of the 15 sons (H–107 to H–127, inclusive) of Mapleside King Paul (H–104), the first proved sire used in the breeding work, show a distinct increase in milk and fat production. (Figs. 5 and 6.) The daughters of the one bull (H–117) that have a decrease in production were not given a fair chance as heifers, in that

they were bred and freshened too young and in most instances were undersized. It is hoped that their records as mature cows will be

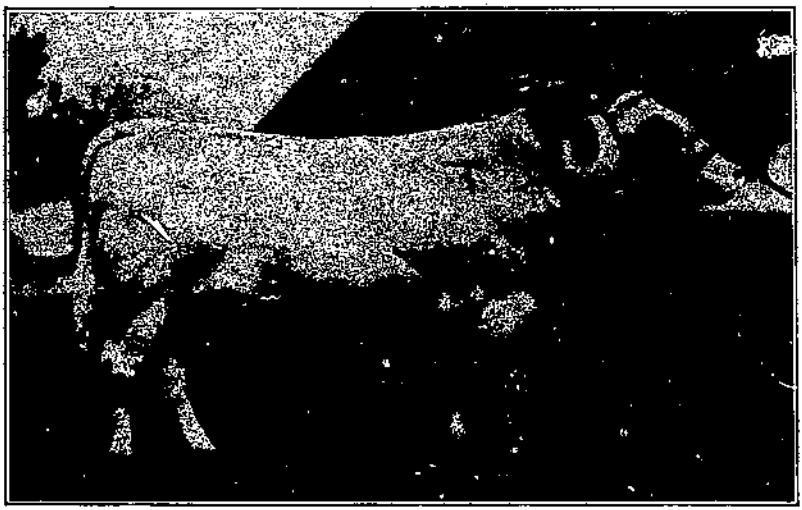

FIGURE 5.—Holstein bull Mapleside King Paul 181023, a proved sire. Twenty-two daughters of this sire averaged 646 pounds of butterfat in a year as compared with an average production of 571 pounds butterfat for their dams. (Records calculated to a mature basis)

made under conditions more comparable with those under which the dams were tested. The 161 daughters of these 15 sires gave an increase

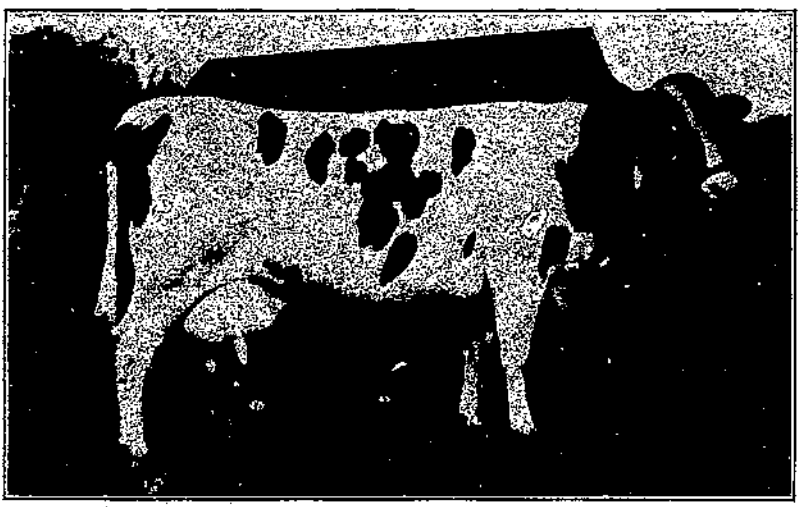

FIGURE 6.—Holstein cow Duchess Sadie Korndyke 764141, a daughter of Mapleside King Paul, having a yearly production as a 7-year-old of 22,611 pounds of milk and 821.9 pounds of butterfat

in production over their dams amounting to 20.92 per cent in milk, 0.8 per cent in percentage of butterfat, and 21.89 per cent in pounds of butterfat.

CARRYING CAPACITY OF PASTURE

In 1916 a tame-grass pasture was started, composed of the following grasses: Kentucky bluegrass, meadow fescue, orchard grass, smooth bromegrass, alsike clover, and white clover. This mixture was seeded at the rate of 24 pounds of seed per acre.

An experiment was carried on from 1919 to 1930 to determine the number of dairy cattle in milk that an acre of irrigated tame-grass pasture would support throughout the grazing season without supplemental feed. It was necessary, however, during several of the seasons to supply additional feed in the form of alfalfa hay or green-cut crops such as corn.

The cattle used in the experiment were, for the most part, registered Holstein-Friesian cows. Several grade cows, however, were used during the seasons of 1919 and 1920. The cows were generally medium producers, although at times it was necessary to use dry cows so as to insure proper grazing. In these instances the pasture received credit for only the number of days grazed by the dry cows and a credit for gain or loss in weight while these cows grazed. A sufficient number of cows were kept on the pasture throughout the grazing season to assure complete use of all available pasture without subjecting the cattle to a shortage of food.

It was necessary at times to remove all cows from the pasture during stormy weather. During these intervals the cows were fed alfalfa hay or other supplemental feeds. Daily milk weights were taken, and butterfat tests were conducted two days in each seven. The pasture was top-dressed each year with 12 loads of barnyard manure and harrowed in the spring to distribute the previous year's droppings.

Table 42 contains a detailed report of this experiment for the years 1927 to 1930 and the average results for the 12-year period 1919 to 1930.

TABLE 42.—*Results of experiment to determine the maximum carrying capacity of 1 acre of irrigated tame-grass pasture for dairy cows at the Huntley field station, 1927–1930, and averages for the period 1919–1930*

Items of comparison	1927	1928	1929	1930	12-year average, 1919–1930
Average daily number of cows per acre	2.73	1.99	1.92	1.92	2.15
Length of grazing season ..... days	138	142	133	160	139.8
Cows on pasture ..... do	138	142	133	147	136
Cows off pasture ..... do	0	0	0	13	.27
Total cow days per acre ..... do	377	283	256	286.5	293
Green corn fed cows on pasture ..... pounds	0	0	0	0	154
Alfalfa hay fed cows:					
On pasture ..... do	801	613	0	0	724.5
Off pasture ..... do	0	0	0	13	107.5
Grazing period of cows on outside pasture ..... days	0	0	0	0	1.9
Average weight per cow per season ..... pounds	1,388	1,316	1,327.8	1,498.4	1,261.3
Average gain or loss in weight per cow per season ..... pounds	223	217	−77.1	8.6	83.6
Production per acre:					
Milk ..... do	5,180	6,529	7,364	6,320	6,960.4
Butterfat ..... do	232.7	240.2	274.9	236.7	264.9

An experiment to determine the carrying capacity of an acre of sweetclover as a pasture was carried on during 1927, 1928, and 1929. This pasture was handled in nearly all respects like the tame-grass pasture. The cows were average producers as a whole,

and occasionally dry cows were used to keep the pasture properly grazed. In maintaining the sweetclover pasture a new seeding was made each year. Only the second season's growth was pastured. Both the yellow-flowered and white-flowered varieties were used, and judging from observations made during the grazing season, the cattle seemed to prefer the yellow-flowered variety. However, while the cattle gradually accustomed themselves to the sweetclover, they did not seem to relish it at any time. Table 43 contains the data for the 3-year period.

TABLE 43.—*Results of experiment to determine the maximum carrying capacity of 1 acre of irrigated sweetclover pasture for dairy cows at the Huntley field station, 1927–1929*

Items of comparison	1927	1928	1929	Average
Length of grazing season.....days..	111	105	110	108.6
Cows on pasture.....do....	96	105	110	103.6
Cows off pasture.....do....	15	0	0	5
Total cow days per acre.....do....	174.4	163.0	162.2	166.5
Average daily number of cows per acre.....	1.57	1.55	1.47	1.53
Grazing period of cows on outside pasture.....days..	12	0	0	4
Alfalfa hay fed cows:				
On pasture.....pounds..	94.5	0	0	31.5
Off pasture.....do....	208.2	0	0	69.4
Average weight per cow per season.....do....	1,354.0	1,174.0	1,437.0	1,321.9
Average gain or loss in weight per acre per season.....do....	−108.2	−244.7	−233.5	−195.5
Production per acre:				
Milk.....do....	4,942.3	3,218.4	2,448.1	3,536.3
Butterfat.....do....	197.8	125.9	95.38	139.69
Skim milk.....do....	4,377.2	2,858.7	2,352.72	3,196.2

FEEDING EXPERIMENTS

EFFECT OF PLANE OF FEEDING ON MILK PRODUCTION

Experiments were conducted to obtain information as to the relative economy of milk production by cows fed on three planes termed "roughage," "limited grain," and "full grain." The first group of cows received all the roughage that they would consume, such as corn silage, alfalfa hay, and root crops in season, and in addition were placed on irrigated pasture during the grazing season. Cows in the other groups were given all the roughage that they would consume and in addition the limited-grain cows received 1 pound of grain to every 6 pounds of milk produced and the full-grain cows received twice this amount of grain. The grain mixture used in the rations of both the full-grain and limited-grain groups was composed of 2 parts of mill feed, 2 parts of ground oats, 2 parts of ground corn, and 1 part of linseed meal. Ten cows were used in the experiment, each cow completing a lactation period on each of the three planes at one time or another during the 7-year period 1919–1926. As a rule, the cows were placed on the full-grain ration first in order that an index of their producing ability might be obtained as soon as possible for inheritance studies. Their records were made under official-test conditions, the cows being milked three times a day. Table 44 contains data from this experiment.

TABLE 44.—*Comparison of the effect of three planes of feeding on milk production by 10 cows at the Huntley field station*

Items of comparison	Average for cows fed—		
	Roughage	Limited grain	Full grain
Age of cows.....years	6½	7	4½
Ration:			
Alfalfa hay.....pounds	6,376	5,978	6,782
Silage.....do	11,234	12,076	8,501
Beet pulp.....do	65	2	244
Beets.....do	1,345	521	2,258
Pasture.....days	132	138	120
Grain.....pounds		2,710	5,266
Weight of cows [1].....do	1,240.2	1,330.6	1,237.7
Gain in weight during test.....do	30	108	180
Dry period prior to test.....days	78	55	56
Grain fed while cows were dry.....pounds	132	111	186
Calf-carrying period.....days	175	155	188
Milk produced:			
Actual.....pounds	13,295.2	16,407.2	15,793.3
Calculated to maturity [2].....do	13,656.5	16,648.6	17,851.5
Butterfat produced:			
Percentage of milk	3.49	3.51	3.45
Weight, actual.....pounds	464.11	576.45	544.43
Weight, calculated to maturity [2].....do	478.00	584.20	619.90
Value of butterfat and skim milk [3].....dollars	252.07	312.76	295.70
Cost of feed exclusive of pasture [4].....do	05.13	105.00	150.46
Cost of feed including pasture [5].....do	91.49	127.15	163.64
Returns over cost of feed.....do	160.58	185.61	132.06

[1] The average weight of the group was based on an average weight of each individual in the group. The average weight of the individual was determined by averaging her monthly weights throughout the testing period.

[2] Individual records in each group when made by an animal in heifer form are calculated to represent her production at mature age.

[3] Computed in the following values: Butterfat, 44 cents per pound; skim milk, 40 cents per 100 pounds.

[4] Computed on the following values per ton: Grain, $32; alfalfa hay, $10; silage, $5; dried beet pulp, $35; beets, $6.

[5] Cost of pasture per day: For cows on roughage alone, 20 cents; on limited grain, 16 cents; on full grain, 11 cents.

In comparing the results it is noted that the roughage group gained 30 pounds in body weight, indicating that this group consumed a sufficient amount of nutrients to meet the demands of production and the requirements of body maintenance. However, 3 individuals in this group were not mature, in that they were between 4 and 5 years of age. Whether the lack of maturity in these instances is a factor of importance in considering the loss or gain in body weight is not known. On the other hand, the limited-grain group gained 108 pounds and the full-grain group gained 180 pounds. The limited-grain group contained 1 individual under 4 years of age at the beginning of the trial, whereas the full-grain group contained 7. If considerable importance is attached to the factor of age, it is apparent that the latter two groups received more nutrients than required, especially the full-grain group. From an economic standpoint the roughage group returned an income over the cost of feed of $160.58, the limited-grain group $185.61, and the full-grain group $132.06. It is apparent that the full-grain group wasted feed.

It appears from this experiment that under conditions at this station an abundance of first-quality roughage is a prime requisite for economical milk and butterfat production and that a light supplemental feed of grain may be advantageously supplied when cows of better than average production are maintained.

ALFALFA-MOLASSES SILAGE

An experiment to determine the desirability of a legume silage for dairy cows was conducted in 1928 and 1929. Fresh-cut alfalfa was ensiled and was moistened with sugar-beet molasses at the rate of 1 part of molasses to 20 parts of alfalfa by weight to provide the necessary sugars for fermentation. This produced a grade of silage of good keeping quality, possessing a characteristic although not objectionable odor. The freshly mowed alfalfa was hauled to the silage cutter and run into the silo in the same manner that corn is handled. The molasses was diluted with warm water and thoroughly sprinkled over the alfalfa as it went into the silo.

Two fresh cows were used in the experiment in 1928 and were fed corn silage and alfalfa-molasses silage ad libitum over a period of 139 days, from July 15 to November 30. No other supplemental feed such as grain or hay was offered. One of the cows, H–48, freshened on July 12 and produced 49.3 pounds of milk on July 15. On the concluding day of the period she produced 26.8 pounds of milk. Her decline in production was the most rapid during the first 30 days, the yield having dropped to 35.4 pounds on August 15. From then on throughout the balance of the trial she maintained a fairly constant milk flow.

Her stable mate, H–49, freshened on July 30 and produced 34.1 pounds of milk on August 1. The decline in production was not unusual, although it might have been anticipated that she would have produced more milk to start with, had she been receiving feed of a different character prior to freshening, as did H–48.

During the first 11 days of the trial the cows consumed on an average 25.3 pounds of alfalfa-molasses silage and 19.3 pounds of corn silage. On July 25 the corn silage became exhausted so that alfalfa-molasses silage alone was fed from that date up to and including August 29. In this period there was an average daily consumption of 45 pounds of alfalfa-molasses silage. Cow H–48 consumed as high as 60 pounds of this silage in one day, while H–49 consumed as much as 50 pounds in one day. During the interval from September 8 to 21 the alfalfa-molasses silage was discontinued, and corn silage alone was fed. H–48 consumed as high as 69 pounds and H–49, 63 pounds in one day. On September 22 alfalfa-molasses silage was again added to the ration, and both cows were fed ad libitum throughout the remainder of the trial. During this period of 70 days there was an average consumption of 46.8 pounds of corn silage and 21 pounds of alfalfa-molasses silage. The daily consumption by the individuals varied greatly, ranging from 80 pounds of corn silage and 19 pounds of alfalfa-molasses silage on October 27 to 20 pounds of corn silage and 55 pounds of alfalfa-molasses silage on October 15 in the case of H–48. H–49 also showed a similar variation, consuming 70 pounds of corn silage and 17 pounds of alfalfa-molasses silage on October 27, while on October 23 she consumed 20 pounds of corn silage and 50 pounds of alfalfa-molasses silage. During the 139 days cow H–48 lost 130 pounds in body weight, while H–49 lost 421 pounds.

The addition of 5 pounds of straw to their ration did not seem to satisfy a craving exhibited by the cows throughout the trial. They refused to eat this additional roughage after several days. On the other hand, an alfalfa-hay supplement of 5 pounds daily per cow was readily eaten when offered in a feeding trial to two cows in milk

during a period of 43 days. In this phase of the feeding trial corn silage and alfalfa-molasses silage were offered ad libitum with an allowance of 5 pounds of alfalfa hay per cow per day. A gradual decline in milk production was observed, the decline, however, being about normal, in that no sharp drop occurred with either cow. The cows in this instance were milking 50 pounds each at the start of the trial and 43 days later were producing within from 5 to 8 pounds of their first day's production. Their average daily consumption over this period was 30.5 pounds of corn silage and 10.5 pounds of the alfalfa-molasses silage and 5 pounds of alfalfa hay. One of the cows ate considerably more of the alfalfa-molasses silage than did the other, the one consuming 664 pounds and the other 236 pounds. One cow lost 169 pounds in body weight, and the other lost 167 pounds in the 43 days of the trial.

Conclusions drawn from these two trials are that large amounts of legume silage such as alfalfa-molasses silage will be consumed by milk cows provided their ration is restricted in variety and amount of other feeds. The individual cow varies considerably in her appetite for alfalfa-molasses silage. Alfalfa as a silage may be warranted when a succulent feed is desired in localities where corn silage can not be profitably produced. It may be profitably fed as a supplement to other roughages in the ration. Considerable loss in weight can be expected if alfalfa-molasses silage forms a large part of the ration for cows giving considerable quantities of milk.

FEEDING COWS ON ALFALFA HAY ALONE

An experiment is in progress to determine the effect on production, health, and economy of production of cows fed for entire lactation periods or longer on alfalfa hay alone. Some of the cows in this experiment have completed records on one or more of the three planes of feeding in an experiment previously mentioned (p. 44). Those records, together with the fact that alfalfa hay is plentiful, should make the results very significant for this locality.

Results so far indicate that cows will consume large quantities of hay and will produce sufficient quantities of milk and butterfat to make their production very economical. Considerable body weight is lost early in the lactation period, but this weight is gradually regained later in the lactation period.

ORNAMENTAL TREES AND SHRUBS[7]

Since becoming established, the trees and ornamental shrubs on the station and in the 4-acre tract known as Project Park, adjoining the station grounds, have attracted attention from the standpoint of beautifying the farmstead as well as providing shade, windbreaks, and screens.

The first plantings were made in 1914 around the station buildings. These plantings have been extended from time to time as the station grounds have expanded. The park was planted in 1917. The nursery stock for the various plantings on the station and in the park were obtained from dealers and from the United States Northern Great Plains Field Station at Mandan, N. Dak. The plantings have been given ordinary care in cultivation, pruning, and irrigating and provide a practical demonstration as to what may be done in a few years' time with this material on the farms of the Huntley project.

[7] Report prepared by A. E. Seamans.

The trees and shrubs used in the various plantings are given in the following list:

TREES

Common name	Scientific name
Ash, green	*Fraxinus lanceolata.*
Boxelder	*Acer negundo.*
Cottonwood, northern	*Populus monilifera.*
Elm, American	*Ulmus americana.*
Elm, Chinese	*Ulmus pumila.*
Linden, American	*Tilia americana.*
Maple, Norway	*Acer platanoides.*
Pine, western yellow	*Pinus ponderosa.*
Plum, American	*Prunus americana.*
Cottonwood, Carolina	*Populus angulata.*
Poplar, northwest	*Populus* sp.
Poplar, silver	*Populus alba nivea.*
Russian-olive	*Elaeagnus angustifolia.*
Spruce, Black Hills	*Picea glauca albertiana.*
Walnut, black	*Juglans nigra.*
Willow, diamond	*Salix mackenzieana.*
Willow, Russian golden	*Salix vitellina aurea.*
Willow, laurel	*Salix pentandra.*

SHRUBS

Barberry, Japanese	*Berberis thunbergii.*
Buckthorn, common	*Rhamnus cathartica.*
Cranberrybush, European	*Viburnum opulus.*
Currant, golden	*Ribes* sp.
Currant, alpine	*Do.*
Dogwood, coral	*Cornus alba sibirica.*
Elder, golden	*Sambucus* sp.
False-spirea, Ural	*Sorbaria sorbifolia.*
Honeysuckle, Tatarian	*Lonicera tatarica.*
Lilac, common	*Syringa vulgaris.*
Lilac, Persian	*Syringa persica.*
Lilac, Japanese tree	*Syringa japonica.*
Mulberry, Russian	*Morus alba tatarica.*
Ninebark	*Opulaster opulifolius.*
Pea-tree, Siberian	*Caragana arborescens.*
Spirea, Vanhoutte	*Spiraea vanhouttei.*
Spirea, Anthony Waterer	*Spiraea* sp.
Snowball, common	*Viburnum opulus sterile.*
Mockorange	*Philadelphus grandiflorus.*

Except for occasional tip killing in severe seasons, all species of trees used have been proved hardy after becoming established. The elms, poplars, boxelders, and willows have made the most rapid growth, while the ash, American linden, maple, plum, and Russian-olive have developed more slowly. Pine and spruce have not only been difficult to transplant successfully but have grown very slowly.

Under irrigation the elms, particularly the Chinese, and in some instances the boxelders, have made a top-heavy growth and many of the trees have been damaged during windstorms by the splitting off of large limbs. The Chinese elm has been free from insect pests, but a number of the trees have been injured by a canker which has entered the tree through pruning or accidental wounds. The American elm has frequently been found infested with aphids but apparently has been free from disease.

The poplars have usually developed into large, well-formed trees more quickly than have the other species, but because of the attacks of borers and certain bark diseases they have proved to be rather short lived.

Aphids, the "boxelder bug," and the larvae of various moths have commonly been found in the boxelder trees in these plantings, but have seemingly done little injury to the trees. Aside from occasional breaking off of top-heavy limbs during severe winds, this tree has proved to be well adapted to the climatic and soil conditions of this locality.

Willows have generally made a rapid and dense growth, especially when planted along the banks of canals and irrigation ditches. When planted closely, the willows have served well as screens and windbreaks. All species have been relatively free from diseases and insect pests.

No serious disease has yet been found on the ash, American linden, maple, or plum. Various larvae have been found on these trees at times, and the foliage of all has been more or less mutilated by leaf-cutter bees during the summer.

The Russian-olive when grown as a tree has shown no injury from insect pests and only slight evidence of disease. In a Russian-olive hedge maintained at the station for several years a number of the plants were killed by crown gall.

A few black walnut trees were planted on the station in 1911, and in 1919 a small number of the same species were set out in Project Park. The older trees have made a very satisfactory growth and for several years have borne fair crops of nuts. The trees planted in 1919 died three or four years later from injuries rather than because of a lack of hardiness. The black walnut has so far been free from disease and serious insect pests.

Numerous conifers have been planted at the station from time to time, but in most cases the percentage of survival has been low. Nursery stock of spruce dug and shipped with a ball of earth surrounding the roots has become established more quickly and the loss has been less than with stock that had the earth removed from the roots at the time it was dug or in preparation for shipment. The growth of pine and spruce has been slow, but the trees appear to be free from troublesome insects and disease.

Practically all of the shrubs listed as being grown at Huntley have shown winter injury in some seasons, but in no case has such injury been severe enough to cause the death of the plant. Perhaps the least susceptible to winter injury have been the cranberrybush, Siberian pea-tree, and dogwood. Spirea, barberry, currant, honeysuckle, lilac, buckthorn, and snowball have frequently suffered the killing back of tips and young shoots during the winter or early spring. The golden elder and Russian mulberry have killed back heavily nearly every winter, and during severe seasons practically all of the aboveground growth has been killed. These species grow rapidly, however, and by midsummer have usually become reestablished.

With the exception of an occasional infestation of tent caterpillars on the currant and aphids on the snowball, the shrubs have been practically free from injurious insect pests. Mildew and leaf spot on both species of currant have so far been the only diseases that have required treatment.

Practically all of the shrubs have been used in group plantings on lawns, around the station buildings, and in windbreaks associated with trees, although a few specimens of Vanhoutte spirea and lilac have been planted singly on the station grounds. Buckthorn and Siberian pea-tree have each been grown in ornamental hedges and have proved to be very effective when used for this purpose.

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