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Winter Grain in South Dakota

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AUGUST, 1915.

AGRICULTURAL
EXPERIMENT STATION

South Dakota
State College of Agriculture
and Mechanic Arts

AGRONOMY DEPARTMENT
CO-OPERATING WITH
OFFICE OF CEREAL INVESTIGATIONS,
BUREAU OF PLANT INDUSTRY, U. S.
DEPARTMENT OF AGRICULTURE

Winter Grain in South Dakota

BROOKINGS, SOUTH DAKOTA.

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WINTER GRAIN IN SOUTH DAKOTA

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WINTER GRAIN IN SOUTH DAKOTA.

By A. N. Hume, Manley Champlin and J. D. Morrison.

Introduction.

Winter grain, both wheat and rye, have certain apparent advantages over spring grain. These are as follows:

1. They permit division of labor both seeding and harvest.
2. They ripen early and frequently evade froth, hail storms and plant diseases.
3. Under favorable conditions the winter grain out-yields spring grain of the same type.

Since winter grain possesses these advantages over spring grain it would seem strange at first thought that winter grain is not more generally grown in South Dakota. Upon careful consideration it will be seen that owing to the very fact that winter grain is winter grain, that is, that it must live thru a winter before it can produce a crop, there are certain disadvantages that must be overcome if success is to be attained in the production of these crops. The disadvantages may be listed as follows:

1. There is not always sufficient moisture in the fall to germinate the seed on ordinary stubble or fall plowed land.
2. Blowing soil, snow and ice particles may injure the crowns of the plants and thus destroy them.
3. Rabbits may destroy part or all of the crop in thinly settled sections of the state.
4. An ice sheet or alternate freezing and thawing may destroy the crop, particularly in poorly drained land.

THE EXPERIMENTAL WORK.

To learn how to overcome such difficulties and thus help make it possible for the South Dakota farmer to obtain a part in the advantages above enumerated the South Dakota Experiment Station, with the cooperation of the Office of Cereal Investigations of the Bureau of Plant Industry, United States Department of Agriculture, is carrying on a definite line of experiments at five farms representing the different soil and climatic conditions of the state at Brookings, Highmore, Eureka, Cottonwood and Newell. These studies have eight objects in view:

1. To determine the average comparative value of spring wheat, winter wheat and winter rye in the various districts.

2. To determine the hardiest and highest yielding varieties.

3. To create new pedigreed varieties by selective crop breeding.

4. To learn some method of insuring sufficient moisture for autumn germination.

5. To compare various methods of winter protection for the young plants and learn which are most effective.

6. To learn the best amount of seed to sow in the various districts.

7. To learn whether or not, the exact time of seeding is of importance.

8. To create a winter grain map of the state, that is, to learn in which sections winter grain may be and in which it may not be successfully produced.

Some progress has been made in this investigation. It is the purpose of this bulletin to set forth in detail, the results obtained to date, together with such conclusions as are warranted by the said results, giving brief reference to the climatic and soil conditions in the various parts of the state where the work was done.

GENERAL CLIMATIC CONDITIONS.

South Dakota, like ancient Gaul, may be roughly divided into three parts with reference to climatic conditions as shown by the accompanying map, Fig. 1, namely the eastern third, the western two-thirds, exclusive of the Black Hills, and the Black Hills region. In the eastern third the rainfall amounts to about twenty inches per year, about three-fourths of which occurs in the growing season. There is a gradual decrease from east to west with the exception of the Black Hills region. With this exception the rainfall in the western two-thirds is approximately sixteen inches, about three-fourths of which occurs in the growing season. In this section frequent periods of high temperature, and high wind velocity reduce the effectiveness of the rainfall. In the Black Hills region, the rainfall again amounts to approximately twenty inches per year. The accompanying table No. 1, shows the average precipitation by months and years at all of the experimental farms for the years 1910 to 1914.

TABLE I.

AVERAGE RAINFALL BY YEARS AND MONTHS AT THE EXPERIMENT STATION FARMS 1910-1914.

STATION	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Apr 1 to Aug 31	For the Year
Belle Fourche	0.34	0.28	0.62	1.23	1.05	1.54	1.33	1.40	2.14	1.09	0.25	0.25	7.15	12.10
Brookings.....	0.44	0.33	0.43	2.24	3.48	3.27	2.43	3.00	2.10	2.04	0.24	0.23	14.51	20.42
Cottonwood....	0.21	0.37	0.91	1.73	2.03	1.62	1.19	2.91	1.61	0.91	0.13	0.95	7.98	13.07
Eureka.....	0.34	0.58	0.64	1.42	1.78	2.76	1.31	2.61	1.49	0.63	0.19	0.44	9.88	14.19
Highmore.....	0.25	0.32	0.94	1.54	2.45	2.04	1.75	1.78	1.24	0.80	0.15	0.35	9.56	13.61

GENERAL SOIL CONDITIONS.

Comparatively little definite information is available about the soil of South Dakota. In general, it may be said that the soils east of the Missouri river are glaciated black or dark loams varying in depth, physical quality and fertility. The soils west of the Missouri river are residual or alluvial in their origin, that is they were either formed by the decay of the underlying rock in place or by the action of water. This helps to account

for the fact that soils in the western district are far more variable than the soils of the eastern district. In general this western district consists of a silt loam area in the north, a sticky clay or gumbo area in the center and a silt loam area in the south, grading into a very sandy soil at the extreme south.

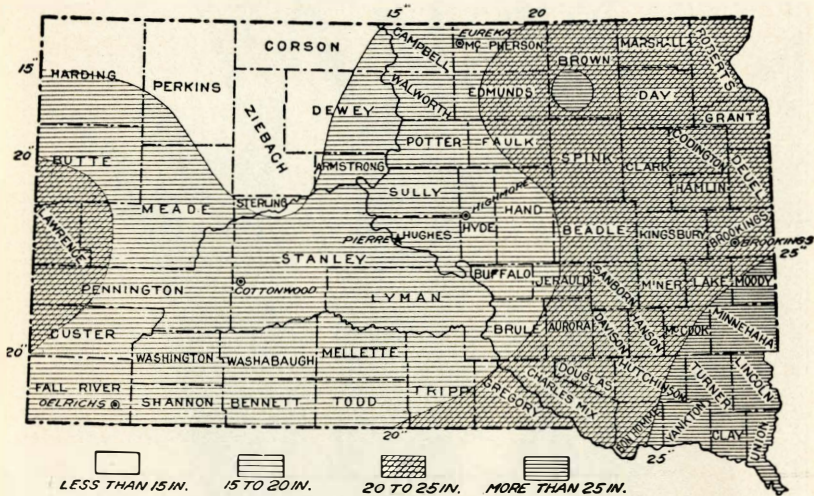


Fig. 1. Map of South Dakota showing the average annual precipitation in inches and the location of the agricultural experiment station and substations. Also in Bulletin 39, U. S. Dept. of Agriculture.

RESULTS AT BROOKINGS.

The Brookings farm of the South Dakota Experiment station is located in the eastern quarter of the state. The soil of the Brookings farm is a dark colored medium sandy loam, often subject to blowing. The rainfall has averaged 22.19 inches per year for the last fourteen years.

Table II shows the rainfall by years and months from 1901 to 1914 with averages by years and months, together with the amount received during the growing season from April to August inclusive.



Turkey Winter Wheat. S. D. 144.

TABLE II.

RAINFALL BY YEARS AND MONTHS WITH AVERAGES AND
NORMALS BROOKINGS 1901-14.

YEAR	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Apr 1 to Aug 31	For the Year
1901	0.090	280.50	1.40	1.804	511.66	2.94	5.090	740.60	0.15				12.31	19.76
1902	0.500	260.67	1.60	2.663	172.75	5.300	261.18	0.93	2.52				15.48	21.83
* 1903	0.100	311.87	1.004	534.163	304.25	2.73	1.850	10.0	0.45				17.24	24.65
1904	0.040	150.25	1.78	1.824	301.91	0.93	0.933	150.0	0.20	2.0			10.74	15.48
1905	0.221	0.000	681.01	6.146	0.90	984.54	2.16	1.50	2.45	T.			18.76	26.77
1906	0.170	0.020	581.4	3.514	891.864	285.133	0.010	890.52					15.94	26.26
1907	1.060	280.55	1.172	365.653	771.411	280.960	101.12						14.36	19.71
1908	0.201	801.162	106.466	354.692	373.891	421.300	60						21.97	32.34
1909	1.201	570.37	1.164	752.292	443.391	671.710	651.14						14.03	22.34
1910	1.0	0.400	502.340	871.851	682.450	960.380	170.10						9.20	12.78
1911	0.610	530.531	621.903	783.323	813.085	120.230	42						14.43	24.95
1912	0.280	240.263	365.982	492.524	681.610	96	T. 0.20						19.63	23.18
1913	0.020	0.90	452.243	501.962	991.331	551.550	810.09						12.02	16.58
1914	0.220	0.490	421.644	166.671	623.163	322.21	T. 0.33						17.25	24.15
Average	0.41	0.520	0.631	703.674	132.54	3.242	401.120	590.56					15.24	22.19
Normal	0.410	0.490	0.762	0.93	2.43	6.62	452.81	2.041	480.55	0.54			14.25	20.52

*Hail Storm July 15, 1903, destroyed that season's crops except winter rye which had been harvested.



Crop - Winter Wheat

Variety - Kharkov

Strain - S. D. 191

Kharkov Winter Wheat. S. D. 191.

TABLE III.

SPRING WHEAT VS. WINTER WHEAT VS. WINTER RYE.
BROOKINGS 1888-92.

Name of Variety	Crop	Yield—Bushels per acre					
		1888	1889	1890	1891	1892	Average
Rodger's Amber.....	Winter Wheat	15.1	15.1	9.0	15.1	Rust	10.9
Excelsior.....	Winter Rye...	18.0	14.1	24.0	14.1	15.1	17.1
Scotch Fife.....	Spring Wheat	3.2	10.1	9.5	21.0	Rust	8.8
Bluestem.....	Spring Whea	5.9	9.9	21.1	21.5	Rust	11.7

The first experiment on record with winter grain at Brookings was undertaken in the fall of 1887. This experiment consisted of a variety or crop test comparing spring wheat with winter wheat and rye. This test was continued for five years during 1888 to 1892 inclusive. In this test bluestem spring wheat exceeded the Rodger's amber winter wheat in yield by .8 bushel per acre, but it should be noted here that neither of these varieties have since proved to be as well adapted to conditions found here as certain other varieties. The excelsior variety of winter rye excelled all of the wheat varieties in yield. These results are presented in detail in Table III. This favorable showing on the part of winter rye led to its unqualified recommendation in one of the earlier publications of this station both for grain and pasture purposes.

Beginning with the year 1901 a variety test of wheat was started including both spring and winter wheat. The leading varieties of spring wheat, both common and durum and the leading variety of winter wheat have been continued in the test since 1902 with the exception of the years 1908, 1910 and 1911, when for some reason the winter wheat was omitted from the test. This leaves ten years of record in which direct comparison may be made of the average yield per acre as follows:

1. Turkey Winter Wheat S. D. 144.....19.8 bu.
2. Kubanka Durum Wheat S. D. 75.....17.1 bu.
3. Bearded Fife Common Wheat S. D. 67..14.7 bu.
4. Bluestem Common Wheat S. D. 140....12.5 bu.

In 1912 Dean winter rye was included in the

trials so that there are now three years in direct sequence in which the rye may be compared to the leading varieties of spring and winter wheat. Such a comparison of average yields follows:

1. Dean Winter Rye S. D. 177.....41.6 bu.
2. Turkey Winter Wheat S. D. 144.....31.4 bu.
3. Kubanka Durum Wheat S. D. 75.....23.8 bu.
4. Bearded Fife Common Wheat S. D. 67..19.6 bu.
5. Bluestem Common Wheat S. D. 140...16.5 bu.

In 1913 the variety Marquis S. D. 515 was introduced into the state from Canada where it had been originated by breeding on the Canadian government experiment farm at Ottawa. This variety was added to the tests at Brookings in 1913 so that it is possible to compare the yields of Marquis with the other varieties as above for a two year average as follows:

1. Dean Winter Rye S. D. 177.....40.1 bu.
2. Turkey Winter Wheat S. D. 144.....32.5 bu.
3. Marquis Common Wheat S. D. 515.....22.6 bu.
4. Kubanka Durum Wheat S. D. 75.....21.6 bu.
5. Bearded Fife Common Wheat S. D. 67...20.1 bu.
6. Bluestem Common Wheat15.0 bu.

If it is assumed that the average farm value during 1913 and 1914 was 82.5 cents per bushel for wheat and 64 cents per bushel for rye as estimated in the United States Department of Agriculture, Farmer's Bulletin 645, pp. 27 and 30, for December 1 of each year, the average gross returns per acre would have been as follows:

1. Dean Winter Rye S. D. 177.....\$25.66
2. Turkey Winter Wheat S. D. 144..... 26.81
3. Marquis Common Wheat S. D. 515..... 18.65
4. Kubanka Durum Wheat S. D. 75..... 17.82
5. Bearded Fife Common Wheat S. D. 67.... 16.58
6. Bluestem Common Wheat S. D. 140..... 12.37

The above figures are based on the assumption that all wheat was of equal value. As a matter of fact the varieties producing the best yields were also of the best quality so that the actual difference in value was greater

than the above figures indicate, but the order remains the same. Furthermore, the above figures are based on a two year trial in order to include Marquis. The two year trial is not long enough to justify publication were it not for the fact that the two year trial agrees with the ten year and the three year trials as to the ranking of the varieties included.

TABLE IV.
COMPARISON OF WINTER WHEAT WITH SPRING WHEAT
AND WINTER RYE. BROOKINGS 1901-14.

Name of Variety	Crop	S.	D.	C.	I.	1901	1902	1903	1904	1905	1906	1907	1909	1912	1913	1914	Average		
																	11 yrs	10 yrs	3 yrs
Turkey	Winter Wheat	144	...	...	...	8.4	29.1	0.0	21.0	22.0	8.0	9.4	14.4	29.3	33.4	230.8	18.8	19.8	31.4
Swedish	Winter Rye	348	137	...	...	46.8	...	...	28.8	...	...	...	...	...	...	...	...	...	...
Dean	Winter Rye	177	136	...	...	...	...	...	...	...	...	...	...	...	44.6	338.3	341.9	...	41.6
Kubanka	Durum Wheat	75	1440	...	...	9.8	0.0	18.8	16.3	28.6	14.5	11.8	28.0	28.3	15.0	...	17.1	23.8	...
Bearded	Spring Wheat	67	3081	12.3	7.6	0.0	7.3	18.3	22.3	10.9	21.8	18.5	27.6	12.7	14.5	14.7	19.6	...	...
Fife	B'rdless	74	1505	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Eluestem	Spring Wheat	140	2874	14.3	9.6	0.0	4.1	15.7	21.8	9.2	15.1	19.6	23.3	6.7	12.7	12.5	16.5	...	...
Marquis	Wheat	169	3641	...	...	...	...	...	...	...	...	...	...	...	29.3	15.8	...	...	...



Dean Winter Rye. S. D. 177.

GROWING WINTER GRAIN AT BROOKINGS.

Two methods of soil preparation were tested at Brookings for the crop of 1913. In one case, the land which had raised a crop of oats was plowed five inches deep during the last week in August harrowed immediately, rolled with a corrugated roller and harrowed again. The wheat was drilled three inches deep, at the rate of one bushel per acre, from east to west with a double disc drill, during the first week in September. This placed the wheat seed in narrow troughs with ridges between. During the windy weather of fall and winter the soil from the ridges drifted into the troughs and protected the crowns of the wheat plants almost as effectually as snow would have done. The winter of 1912-13 was practically snowless so that the test was a severe one, but the wheat wintered with a good stand. Another small field on fall plowing was harrowed until quite level after seeding. On this field the wheat was all killed during winter. The reason was apparent, as in many cases the wheat crowns stood half an inch above the surface of the ground in the spring, the soil having drifted away from them.

IN STANDING CORN.

During the same season and on the same day another field was seeded at the same rate, to the same depth and in a similar direction with a fiveshoe, one horse drill in the standing corn. The stalks were left on the land to protect the wheat. The wheat was seeded so that there were eight inches between the rows. This left twenty-two inches between each group of five rows. In early spring the corn stalks were broken over.

The wheat stooled remarkably well and occupied nearly all the space so that the corn stubble rows were not noticeable after the wheat had headed out.

THE YIELDS.

The variety used in this test was Turkey S. D. 144.

All conditions were as near uniform as it was possible to make them except the previous crop and preparation. The rotation on which the crop was grown was corn, oats, wheat, clover in the one case and corn, wheat, oats, clover in the other. The resulting yields were as follows:

Winter Wheat after Corn.....28.7 bu. per acre

Winter Wheat after Oats.....19.2 bu. per acre

In the fall of 1913 the corn stalks were removed to determine whether it would be possible to bring the wheat through the winter and also utilize the stalks. The corn stubble was left about twelve inches high. This method also proved satisfactory for the given season, the resulting yield in 1914 being 30.8 bushels.

WINTER RYE.

Similar methods to those above described were also tried in 1914 with winter rye with the following results:

Winter Rye after Rye.....26. bu. per acre

Winter Rye after Corn.....41.9 bu. per acre

Winter Rye after Mixed Grasses 37.1 bu. per acre

RATE OF SEEDING.

Tests were started in 1913 to determine the best rate of seeding winter wheat in eastern South Dakota. Conclusive results have not been obtained and the test will be continued. The results to date are presented in Table V. The most profitable average yield was obtained by seeding seven pecks. It should be noted that in the season of 1914 seeding four pecks per acre gave the most profitable returns. Until the test has been conducted long enough to settle this question, it is suggested that four to five pecks per acre is the amount of seed apparently most profitable to use. The thick seeded fields both seasons were noticeably crowded with plants and as a result, the grain graded lower than that from the fields where a lower rate of seeding was used.



Crop - Emmer

Variety - Black winter

Strain - S. D. 346

Black Winter Emmer. S. D. 346.
This crop has not proved successful for South Dakota conditions.

TABLE V.

RATE OF SEEDING TEST ON TURKEY S. D. 144 WINTER WHEAT
AT BROOKINGS.

Rate of Seeding	1913		1913		1914		Average	
	Following Oats Grain Bu | Straw Cwt	In Corn Stalks Grain Bu | Straw Cwt	In Corn Stalks Grain Bu | Straw Cwt	In Corn Stalks Grain Bu | Straw Cwt	Grain Bu | Straw Cwt	Grain Bu | Straw Cwt	Grain Bu | Straw Cwt	
2 pecks	15.3	11.3	20.8	16.7	26.7	36.0	22.4	25.0
3 pecks	15.8	11.9	26.5	18.6	28.3	37.0	24.7	26.1
4 pecks	16.7	11.6	27.7	19.0	30.8	36.5	26.5	25.9
5 pecks	20.0	13.6	30.0	16.6	30.8	35.5	27.9	25.3
6 pecks	21.5	14.5	34.2	20.1	28.3	35.0	28.1	26.1
7 pecks	25.7	16.9	32.7	19.1	28.3	34.0	28.8	26.0

A similar test with winter rye was begun in 1914, in which three, four and five pecks per acre were sown. The resulting yields were almost identical, about thirty-six bushels in each case. **THUS THE MOST PROFITABLE RATE OF SEEDING IN THIS CASE WAS THREE PECKS PER ACRE.** This result was obtained on clean cultivated corn land.

RESULTS AT HIGHMORE.

SOIL AND CLIMATE.

The Highmore farm of the South Dakota Experiment Station is located in the area lying between the James and the Missouri. The soil is a dark colored, medium clay loam of glacial origin. The rainfall has averaged 16.87 inches per year since these experiments have been in progress. The rainfall by years and months with averages and normals is given in the accompanying Table VI.

TABLE VI.

PRECIPITATION WITH AVERAGES AND NORMALS BY YEARS
AND MONTHS 1903-14.

YEAR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	April 1 Aug 31	For the Year
1903	0.05	0.30	0.87	0.70	0.85	2.93	3.58	2.40	1.46	0.66	0.65	0.63	10.46	15.08
1904	0.15	0.17	0.05	1.43	0.99	2.25	2.40	1.48	0.38	0.60	T.	0.60	8.55	10.50
1905	0.60	T.	0.66	1.39	5.23	5.64	5.54	3.56	0.56	1.95	1.29	T.	21.36	26.36
1906	0.30	0.40	0.80	2.40	5.00	2.56	1.19	6.35	2.80	0.30	2.47	0.40	17.44	24.91
1907	1.00	0.40	1.10	0.68	5.11	6.23	6.40	1.81	0.41	0.62	0.05	0.40	11.23	17.18
1908	0.10	0.30	0.86	1.55	2.68	5.78	2.49	3.53	0.62	1.91	3.90	0.31	16.43	22.37
1909	0.26	0.34	0.13	0.30	4.72	1.69	1.81	3.92	1.70	1.04	0.71	1.41	12.44	18.03
1910	0.82	0.19	0.58	1.40	0.94	3.74	0.85	0.66	0.89	0.24	0.40	0.44	7.59	11.15
1911	0.11	0.39	0.54	0.32	2.31	0.09	2.69	2.52	3.06	1.05	0.35	0.44	7.93	15.87
1912	1.15	0.11	0.27	1.65	2.20	1.31	1.44	3.39	0.71	0.20	0.00	0.35	9.59	12.16
1913	0.05	0.30	0.87	1.27	4.56	0.97	1.79	2.60	0.53	0.61	0.03	0.28	9.79	12.46
1914	0.15	0.62	0.45	3.65	2.23	4.09	2.01	1.16	1.01	1.92	T.	0.25	13.14	17.52
Average	0.39	0.34	0.75	1.34	3.07	2.72	2.45	2.53	1.25	1.06	0.61	0.46	12.11	16.95
*Normal	0.26	0.24	0.91	1.70	2.42	3.10	2.47	2.38	1.38	1.00	0.43	0.40	12.13	16.73

*Normal as recorded by the Weather Bureau of the U. S. Dept. of Agr.

PROBABLE RETURNS.

In 1905 experiments were begun at Highmore to determine whether ANY VARIETY OF WINTER WHEAT COULD BE PROFITABLY GROWN, and to attempt to select and pedigree a race that would be hardy. The varieties Turkey S. D. 144 and Kharkov S. D. 59 are the only ones that have shown any possibility of being hardy enough to be profitable. The cold bare winters with their accompanying wind frequently kill the winter wheat. Jack rabbits have also given much trouble and killed the wheat by nibbling into the crowns of the plants.

In a test comparing the hardiest varieties of winter wheat, with the leading varieties of spring wheat, begun in 1905 and carried on continuously except in 1909 and 1910 the results were obtained which are shown in Table VII. It will be noted that the Turkey is not reported after its failure in 1911 and the record is continued with Kharkov S. D. 59, it being the only variety that proved hardy in the winter of 1911-12. Considering the seven year average which includes the years 1905, '06, '07, '11, '12, '13 and '14 the crops rank in the following order:

1. Kubanka S. D. 75 Durham Wheat14.5 bu. per acre

2. Dean and Swedish Rye .. 14.1 bu. per acre
3. Bearded Fife S. D. 67
Spring Wheat 12.0 bu. per acre
4. Bluestem, Minnesota 51,
Spring Wheat 9.8 bu. per acre
5. Turkey and Kharkov
Winter Wheat 9.0 bu. per acre

It is worthy of note that during the entire period winter rye has never failed. In the year 1911 when so serious a drouth prevailed that wheat failed the rye yielded five bushels per acre. This factor of safety is well worth considering when determining what crops to grow in the Highmore area and though Kubanka S. D. 75 wheat has been more profitable than rye as an average, it was the rye crop that would have provided a livelihood during the drouth years 1911 and 1912.

TABLE VII.

COMPARISON OF WINTER WHEAT WITH SPRING WHEAT AND
COMPARISON OF WHEAT WITH WINTER RYE FOLLOWING
CORN AT HIGHMORE.

Name of Variety	Crop	S. D. No.	C. I. No.	Av. yield for year indicated							Average				
				1905	1906	1907	1908	1911	1912	1913	1914	7 years	8 years	Lst. 4 yrs	
Dean	Winter Rye	177	136	25.7	18.1	14.3	5.0								
Swedish	Winter Rye	348	137						6.0	13.8	15.5	14.1		10.1	
Turkey	Winter Wheat	144	1442-	6.8	5.0	32.7	32.8	0.0							
Kharkov	Winter Wheat	59	-18						3.7	2.1	12.5	9.0	12.0	4.6	
Kubanka	Durum Wheat	75	1440	23.2	26.7	28.7	22.7	0.0	1.1	2.9	19.7	14.5	15.5	5.7	
Bearded Fife	Spring Wheat	67	3081	25.5	20.3	18.7	11.0	0.3	0.5	6.5	12.0	12.0	11.9	4.8	
Minn. No. 51	Spring Wheat	74	1505	22.8	17.0	16.0	16.3	0.0	0.0	7.7	4.8	9.8	10.6	3.1	

(a) Both varieties of winter rye are used in making average.

(b) Record for 1908 crop yield was not recorded, although an excellent crop was harvested.

(c) Both varieties of winter wheat are used in making average.

Beginning with 1912, winter wheat has been seeded on summer fallow to compare with the wheat seeded on corn ground. This method is the one commonly used in the dry farming regions of Montana and other western states with marked success but it has proved a total failure at Highmore. The results are given in Table VIII.

TABLE VIII.

VARIETY TEST OF WINTER WHEATS ON FALLOW AND IN CORN STALKS AT HIGHMORE.

Name of Variety	S. D. No.	C. I. No.	Yield Bus. per a.			Spring Survival			3 year av.		2 year av.	
			1912	1913	1914	1912	1913	1914	Bus	Survival	Bus	Survival
Utah												
Turkey	57	2908-1	0.0	0.4	0.2	0.0%	4.0%	1.0%	0.2	2%	3%	0.3
Kharkov	59	1442-18	3.7	0.5	1.7	20.0	4.0	2.0	2.0	9	3	1.1
Kharkov	76	1583		1.1	1.1		8.0	1.0			5	1.1
Kharkov	302	3123		0.2	0.6		2.0	20.0			11	0.4
Kharkov	306	3125		lost	0.3		2.0	2.0			2	0.2
Kharkov	307	3126		0.2	0.3		1.0	4.0			3	0.3
Kharkov	311	3130		1.1	0.6		4.0	10.0			7	0.9
Theiss	352	1561		0.5	0.6		5.0	2.0			4	0.6
Hard												
Winter	353	2943		1.1	1.7		5.0	2.0			4	1.4
Buffum	354	3330	0.0	2.2	1.1		15.0	10.0	1.4	9	13	1.7
Turkey	58	1558	1.0	0.0	0.0	5.0	0.0	0.0	0.3	2	0.0	0.0
Kharkov	191	1442	0.9	4.0	3.2	5.0	60.0	45.0	2.7	37	53	3.6



Kharkov Winter Wheat, S. D. 59, at Highmore 1912, the only wheat which survived the winters of 1911 and 1912.

DEDUCTIONS CONCERNING GROWING WINTER GRAIN AT
HIGHMORE.

The experiments above reported point strongly to the following conclusions:

1. Winter rye is the most dependable small grain crop for this area.
2. Winter wheat is not dependable and even the hardiest varieties yet bred or introduced frequently winter-kill to such an extent as to make them less profitable than bluestem, the lowest yielding spring wheat type.

3. Turkey and Kharkov are the hardiest varieties of winter wheat among those tested at Highmore.

4. The use of the method of summer fallowing has not enabled winter wheat to make a satisfactory yield.

5. Seeding between corn stalks in a clean cultivated field with a one horse drill has been the only method of growing winter wheat that has given somewhat encouraging results.

6. Seeding on fall plowed or disced grain stubble has not proved profitable either for winter wheat or rye.

Farm practice is apparently limited to but two methods of preparing the land for winter rye, namely, by raising a clean cultivated crop of some sort or by summer fallowing.

AMOUNT TO SOW.

In 1913 an experiment was started to determine the amount of seed of winter rye to sow per acre. The results are reported in Table IX. This test is not completed as yet but it will be noted that SEEDING FIVE PECKS PER ACRE HAS GIVEN THE HIGHEST YIELDS OF GRAIN DURING EACH OF THE TWO YEARS. In this test the rye was seeded on corn ground which had been manured at the rate of six tons per acre the year before.

TABLE IX.

RATE OF SEEDING TESTS ON WINTER RYE, HIGHMORE.

Name of Variety	Rate of Seeding	S. D. No.	C. I. No.	1913		1914		Two year average	
				Grain Bu	Straw Cwt	Grain Bu	Straw Cwt	Grain Bu	Straw Cwt
Swedish	2 pecks	348	137	15.0	26.6	12.9	15.0	14.0	21.1
"	3 pecks	"	"	13.1	19.9	15.4	12.7	14.3	16.3
"	4 pecks	"	"	13.5	22.5	15.5	17.0	14.5	19.8
"	5 pecks	"	"	15.7	22.7	20.4	17.3	18.1	20.0
"	6 pecks	"	"	13.6	26.9	20.2	12.9	16.9	19.9

TIME OF SEEDING.

In 1914 a test was conducted in order to determine the best time to seed winter rye. The results are report-

ed in Table X. September 1st to October 1st proved the best time for seeding the rye. Another important fact brought out by this test was that rye seeded TOO LATE TO GERMINATE IN THE FALL OR SEEDED VERY EARLY IN THE SPRING PRODUCED A FAIR YIELD OF GRAIN.

TABLE X.

DATE OF SEEDING TEST ON DEAN WINTER RYE S. D. NO. 177
HIGHMORE, 1914.

Date of Seeding	Yield of Grain Bus. Per Acre	Straw Cwt Per Acre	Weight Per Bu.
September 1	25.2	42.6	53
September 15	27.1	47.5	53
October 1	26.6	47.8	53
November 1	20.6	42.9	53
March 1	14.7	31.4	52
March 15	8.8	21.5	52
April 1	5.9	15.2	51

GROWING WINTER GRAIN AT EUREKA.

Eureka is situated in the western part of McPherson County. The experiment farm is located on a group of rounded glaciated hills known as a moraine. There is a considerable area of such land in the state. The soil in general is a thin layer of sandy loam on boulder clay subsoil. The climate is similar to that described at Highmore.

Table XI. presents the rainfall data thus far obtained. It will be noted that very little precipitation has occurred during the winter months and this makes it easy to understand why it is difficult to grow winter grain in the Eureka area. The soil blows readily and the frequent cutting of soil particles and ice particles has made it difficult for winter grain to survive.

TABLE XI.

PRECIPITATION BY YEARS AND MONTHS WITH AVERAGES,
EUREKA 1909-1914.

YEAR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	April 1 to Aug 31	For the year
1909	0.10	0.45	0.14	0.50	2.65	3.35	2.21	1.39	1.25	0.17	4.50	2.40	10.10	19.11
1910	0.6	1.70	1.23	0.82	0.42	3.80	0.53	2.60	3.65	0.18	T. 0.25		8.17	15.78
1911	0.50	0.73	0.62	2.24	0.97	1.29	0.43	3.57	1.15	0.61	0.88	0.86	8.50	13.69
1912	0.25	0.40	1.05	1.29	3.37	1.52	2.19	3.27	0.43	0.07	T. 0.11		11.62	14.93
1913	0.19	0.03	0.09	0.68	1.97	2.91	2.16	1.53	0.54	1.52	0.08	0.52	9.25	12.13
1914	0.22	0.05	0.22	0.07	2.20	4.28	1.25	2.11	0.70	0.87	T. 0.55		11.91	14.50
Average	0.30	0.56	0.56	1.27	1.92	2.86	1.46	2.41	1.45	0.57	0.91	0.77	9.93	15.02

Table XII. presents the results of a two year test at Eureka in which winter wheat, winter rye and spring wheat were compared both on corn land and fallow. In this case the corn stalks were removed from the land. Winter wheat has not proved profitable during this test. Winter rye, likewise has been less profitable than spring wheat of good variety.

TABLE XII.

COMPARISON OF WINTER WHEAT AND SPRING WHEAT AND
COMPARISON OF WHEAT AND WINTER RYE FOLLOW-
ING FALLOW AT EUREKA STATION.

Name of Variety	Crop	S. D. No.	C. I. No.	Bushels Per Acre		
				1913	1914	A. average
Turkey	Winter Wheat	144		0.0	0.0	0.0
	Spring Wheat			11.3	11.9	
^c Dakota Bluestem	Spring Wheat	196	3 83	11.0	7.2	9.1
Swedish	Winter Rye	348	137	7.5	9.0	8.3

(a) Red Fife S. D. No. 67 C. I. No. 3081 in 1913.

(b) Kubanka S. D. No. 75 C. I. No 1440 in 1914.

(c) Bluestem S. D. No. 196 C. I. 3083 sown where
Winter Wheat killed out.

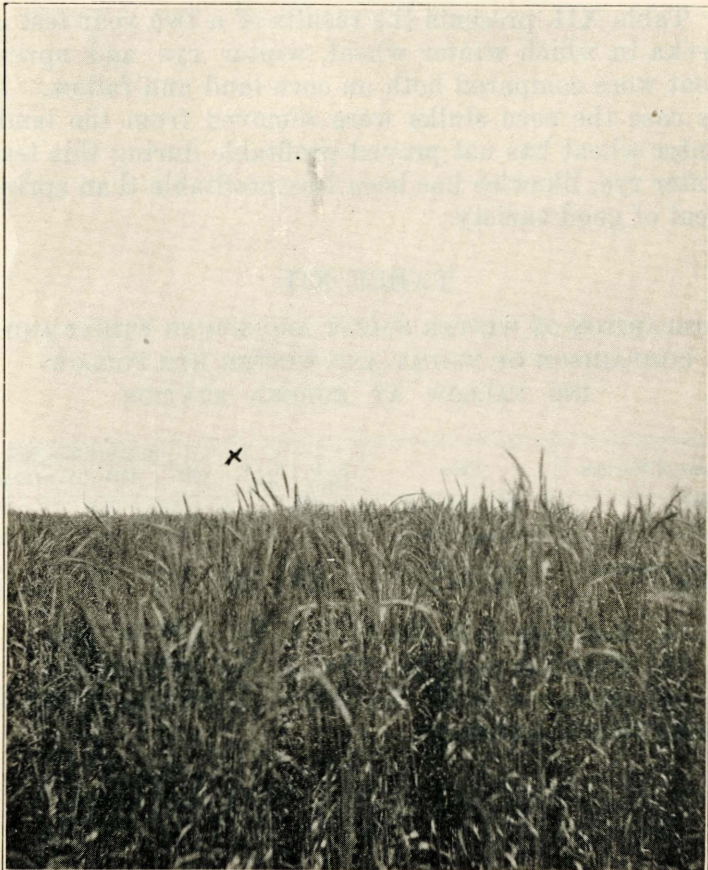
XIII.

COMPARISON OF WINTER AND SPRING WHEAT AND COMPARISON OF WHEAT AND WINTER RYE FOLLOWING CORN AT EUREKA STATION.

Name of Variety		S. D. No.	C. I. No.	Bushels Per Acre		
				1913	1914	Average
Turkey	Winter Wheat	144		a 4.3	0.0	2.2
	Spring Wheat			8.0	b 12.2	10.1
Swedish	Winter Rye	348	137	7.2	8.2	7.8

(a) Red Fife S. D. No. 67 C. I. No. 3081 in 1913.

(b) Kubanka S. D. No. 75 C. I. No. 1440 in 1914.



Winter Rye Breeding Nursery. Highmore, 1914.

The cross indicates an especially promising selection or pedigree variety.

Since it seemed impossible to grow winter wheat in this area without some form of protection or mulch, a mulching experiment was added to the work in the fall of 1914. Three tons of straw per acre were spread evenly over part of the winter wheat late in November. Another part seeded in corn stubble in the same way and still another field seeded on fallow were left without a mulch. In the spring of 1915 the mulched plats had a perfect survival while those not mulched were totally killed. Since machines are now available for straw distribution and since there is an excess of straw in many localities, mulching winter wheat may prove a profitable practice. This experiment at Eureka will be continued and meanwhile it is suggested that others try the method in an experimental way. If a way is found to grow winter wheat successfully and at the same time conserve soil moisture and humus, it should be well worth while.

AMOUNT TO SOW.

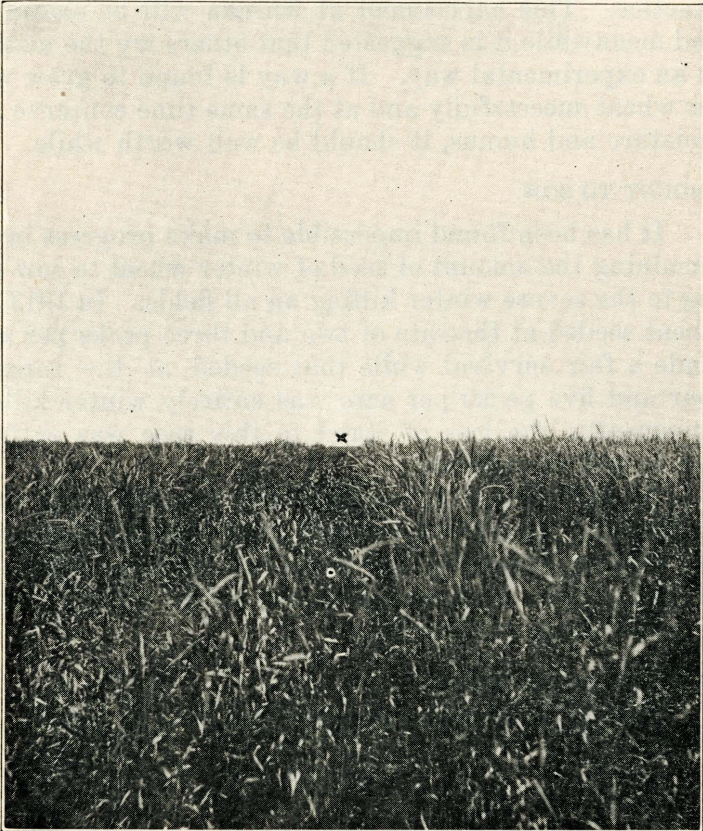
It has been found impossible to make progress in determining the amount of seed of winter wheat to sow owing to the severe winter killing on all fields. In 1913 the wheat seeded at the rate of two and three pecks per acre made a fair survival while that seeded at the rates of four and five pecks per acre was entirely winter killed. Apparently, the loss of stand in this case was entirely due to lack of moisture.

No test of rate of seeding with rye has been made at Eureka. It will be recalled that seeding five pecks per acre at Highmore has given best results in the test at that point. It is assumed that a like amount would be satisfactory at Eureka.

NATURE'S LIMITATIONS.

Basing our judgment upon the results quoted, ob-

tained by comparative trial at Highmore and Eureka, we conclude that winter rye is the only winter grain hardy enough for the conditions in the region between the James Valley and and the Missouri River in South Dakota and that if winter wheat is to be grown at all some method must be found to give it winter protection. Two methods are suggested for trial; first, to seed between standing corn and leave the stalks to catch snow; second, to spread straw over the young wheat for protection late in the fall. If this is tried, care must be used to spread the straw thinly and evenly. Too thick a mulch will destroy the wheat by smothering.



Winter Grain Breeding Nursery, Highmore, 1914. Winter rye indicated by cross shows perfect hardiness

WINTER GRAIN AT COTTONWOOD.

The Cottonwood farm of the South Dakota Experiment Station is located in the area lying between the Missouri River and the Black Hills. The soil of the tillable portion of the experiment farm is Pierre clay. On the flat part of the farm, a portion of the soil is impregnated with alkali to such an extent as to render crop growth impossible. In this section of the state the best soil is found on the upland prairie with its gently sloping hillsides rather than on the level, low lying flats, such as make up the greater portion of the tillable land of the station farm. This statement is made in view of the fact that readers, unacquainted with this section of the state might judge that this entire area is of no value for winter grain production, because of results reported here. By means of reports from members of the South Dakota Experiment Association and from careful observations, it has been ascertained that there is much of this "gumbo" land in the Cottonwood area on which both winter wheat and rye have been profitably produced when seasonal conditions were favorable and the land was properly prepared. Table XIII. gives the rainfall in inches with averages for years and months. The average for the entire period from 1910 to 1914 has been 13.07 inches. Nearly half of this occurred during the fall and winter from September 1st to March 31st.

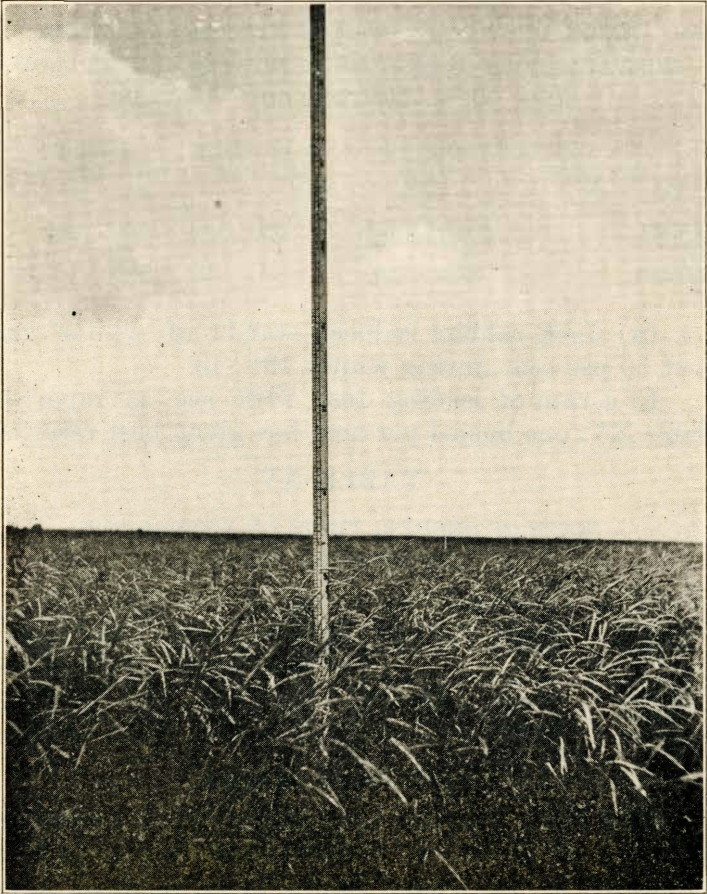
TABLE XIII.

PRECIPITATION BY YEARS AND MONTHS WITH AVERAGES.
COTTONWOOD, 1910-14.

YEAR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Ap Aug 31	1 to For the Year
1910	0.66	0.07	0.76	1.06	2.54	1.34	1.11	0.48	0.82	0.32	0.36	3.01		12.42
1911	T.	0.15	T.	0.85	1.10	0.64	0.59	2.41	3.59	1.15	6.20	0.42	6.49	11.10
1912	0.17	*	3.00	3.32	1.19	0.92	2.42	3.42	1.36	0.11	T.	0.12	11.27	16.34
1913	0.18	0.10	0.43	1.15	2.95	0.59	0.81	1.84	1.15	0.76	0.14	0.38	7.34	10.48
1914	0.03	1.18	0.35	2.26	2.35	1.64	1.04	1.88	1.19	2.23	0.02	0.84	9.17	15.01
Average	0.21	0.74	0.91	1.73	2.03	1.02	1.19	2.01	1.61	0.91	0.13	0.95	7.98	13.44

*No record. Precipitation very slight, average for February used in computing totals.

Winter grain trials have been in progress during 1913 and 1914. The results obtained from a comparison of spring and winter wheat and winter rye are reported in Table XIV. The rye has given better results during the trial than the wheat, again proving its ability to withstand very severe conditions.



Swedish Winter Rye
S. D. 348.
Highmore, 1914.

TABLE XIV.

COMPARISON OF WINTER WHEAT WITH SPRING WHEAT AND
COMPARISON OF WHEAT WITH WINTER RYE FOLLOW-
ING CORN, COTTONWOOD STATION.

Name of Variety	Crop	S. D. No.	C. I. No.	1913	1914	Average Two years
Turkey	Winter Wheat	144		^a 0.4	0.6	0.2
Red Fife	Spring Wheat	67	3081	0.5	2.6	1.5
Swedish	Winter Rye	348	138	^a 0.4	7.8	4.1

(a) Jack rabbits reduced stands of winter grains over 50 per cent during winter 1912-13.

In a rate of seeding test with rye as reported in Table XV. one bushel per acre has given best returns.

TABLE XV.

RATE OF SEEDING TESTS ON WINTER RYE.
COTTONWOOD 1913-14.

Name of Variety	Rate of Seeding	S. D. No.	C. I. No.	1913		1914		2 yr. av.	
				Grain Bus. Per A.	Straw Cwt. Per A.	Grain Bus. Per A.	Straw Cwt. Per A.	Grain Bus. Per A.	Straw Cwt. Per A.
Swedish	3 pecks	348	137	0.2	0.3	8.9	8.7	4.6	4.5
Swedish	4 pecks	"	"	0.3	0.4	7.8	11.0	4.1	5.7
Swedish	5 pecks	"	"	0.8	0.3	7.7	9.0	4.3	4.7

RESULTS AT NEWELL.

The Belle Fourche Experiment Farm located near the town of Newell in northwestern South Dakota is supported by the United States Department of Agriculture. The rainfall as given in detail in Table XVI. does not differ materially from that reported at Cottonwood. The soil of the station is a Pierre clay which is quite representative of that part of the state.

TABLE XVI.

PRECIPITATION BY YEARS AND MONTHS WITH AVERAGES
 BELLE FOURCHE EXPERIMENT FARM AT NEWELL, 1908-14.

YEAR	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	April 1 to Aug 31	For the Year
1908	<i>a</i>	<i>a</i>	<i>a</i>							<i>a</i>	<i>a</i>		8.46	14.23
	0.20	0.19	1.65	1.16	3.95	1.47	1.26	0.62	0.52	2.10	0.20	0.91		
1909	<i>a</i>	<i>a</i>	<i>a</i>										13.30	17.73
	0.17	0.23	0.19	0.84	3.87	5.59	2.45	0.55	1.07	0.76	0.73	1.28		
1910	0.73	0.70	0.93	1.57	1.26	1.51	1.42	1.63	2.92	0.27	0.11	0.10	6.79	12.55
1911	0.13	0.65	0.09	0.17	0.45	0.50	0.80	1.86	0.92	0.39	0.98	0.30	3.78	6.64
1912	0.24	0.16	0.71	2.32	2.60	2.93	2.02	2.86	3.49	0.51	0.64	0.13	10.87	16.69
1913	0.57	0.24	0.99	0.23	1.98	3.10	0.35	0.26	2.38	1.86	0.10	0.45	5.92	12.51
1914	0.65	0.24	0.41	1.86	2.33	2.32	0.86	1.65	1.01	2.42	0.00	0.27	8.42	12.82
Average	0.30	0.25	0.71	1.17	2.30	2.11	1.48	1.17	1.76	1.19	0.31	0.49	8.22	13.23



Winter protection is a prime factor in growing winter wheat in South Dakota. Note how the snow has lodged in the depressions in the plowed land and in the stubble in the rear of picture, but has blown off of the exposed portion of the plowed land.

At Newell, as at Brookings, little difficulty has been experienced with winter killing. A number of varieties that have not proved hardy at Highmore have been successful at Newell but the significant fact remains that the KHARKOV AND ITS NEAR RELATIVE, THE TURKEY, THE SAME VARIETIES THAT HAVE SHOWN OUTSTANDING HARDINESS IN THE TESTS AT HIGHMORE are likewise among the best varieties at Newell. The results of a variety test are given in Table XVII.

TABLE XVII.

VARIETY TEST OF WINTER WHEATS BELLE FOURCHE EXPERIMENT FARM AT NEWELL.

Name of Variety	C. I. No.	S. D. No.	Yield Bushels Per Acre						Average			
			1908	1909	1910	1911	1912	1913	1914	7 yrs	5 yrs	
Theiss	1561	352			19.4				36.8	31.6		17.6
Alberta Red	2979				16.7	failure	failure		35.0	Not Grown		
Beloglina	1667				19.2				37.2	29.9		17.3
Beloglina	2239				19.2				39.4	29.2		17.6
Hard Winter	2943	353			15.0				39.3	Not Grown		
Crimean	1437		25.3	36.0	20.3				36.4	Not Grown		
Turkey	1558		58.24	1.41	0.17	8			38.1	Not Grown		
Turkey	1571		25.5	39.0	20.3				38.7	29.6		21.9
Turkey	3055		22.3	44.5					35.0	29.6	^a	16.2
Kharkov	1442		19.1	25.4	40.3	22.7			38.6	28.7		22.2
Kharkov	1583		76.22	5.39	0.23	6			38.8	29.1		18.0

(a) Six years. (b) Four years.

At Newell, as at Brookings, the winter wheat has proved more profitable than the best varieties of spring wheat as shown by a test reported in Table XVIII.

TABLE XVIII.

COMPARISON OF WINTER AND SPRING WHEATS BELLE
FOURCHE EXPERIMENT FARM AT NEWELL.

Name of Variety	Crop	S. D. No.	C. I. No.	Average for Year Indicated						Average 7 years
				1908	1909	1910	1911-12	1913	1914	
Kharkov	Winter Wheat	191	1442	25.4	40.3	22.7	failure	38.6	28.7	22.2
Turkey	Winter Wheat		1571	25.5	39.0	20.3	failure	38.7	29.6	21.9
	Spring Wheats									
Kubanka	Durum Wheat	75	1440	24.9	21.4	5.8	failure	15.6	16.9	12.1
Power's Fife	Beardless Fife	172	3025	18.5	17.3	10.6	failure	16.6	5.1	9.7
Haynes	Bluestem	140	3020	16.3	13.8	9.0	failure	14.1	5.1	8.3

(a) Not strictly comparable, grown on corn ground instead of fallow.

(b) Directly comparable, grown in regular order with the winter wheats in the same series.

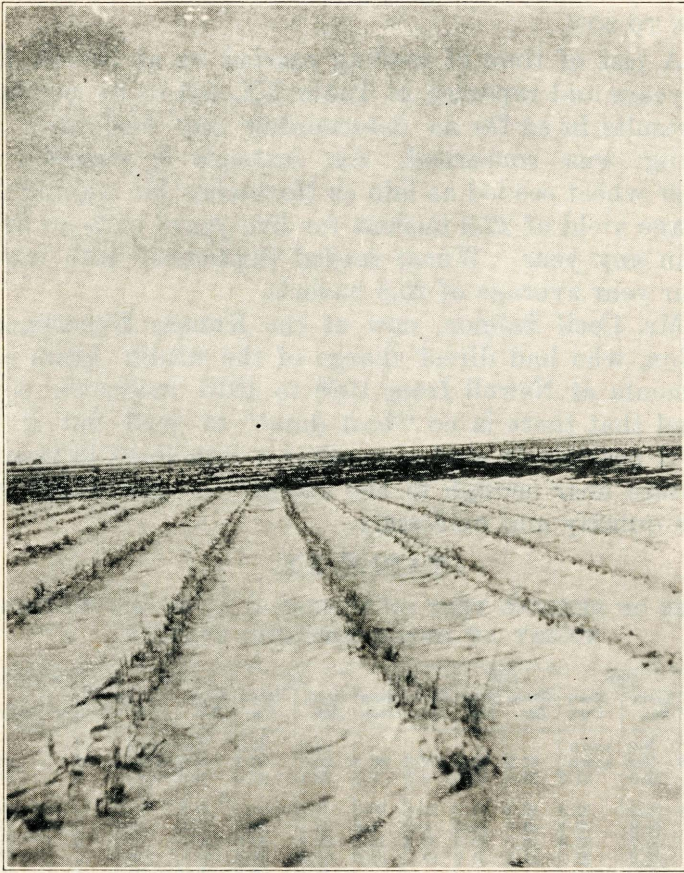
AMOUNT TO SOW.

In 1913 a rate of seeding test was conducted. The amounts per acre seeded were two, three, four, five, six and seven pecks. The resulting yields as reported in Table XIX. varied but little and it was concluded that from three to four pecks per acre would be most profitable.

TABLE XIX.

RATE OF SEEDING TESTS ON WINTER WHEAT BELLE
FOURCHE EXPERIMENT FARM AT NEWELL, 1913.

RATE OF SEEDING	Yield		
	Av. Bus. Per acre	Weight Per Bus.	Cwt Straw Per acre
2 pecks.....	26.4	60.7	28.5
3 pecks.....	28.0	61.5	29.6
4 pecks.....	27.3	60.7	29.2
5 pecks.....	26.8	61.8	32.4
6 pecks.....	27.4	61.5	34.5
7 pecks.....	28.2	61.8	32.6



Highmore, Mar. 14, 1914.

Snow lodging in millet stubble. This furnishes protection for winter grain and conserves moisture for the following crop. The millet is grown in double rows, cultivated. Corn stubble serves the same purpose if cut as high as possible.

WHEN TO SOW.

A test of time of seeding carried on at Newell for five years and reported in Table XX. led to no conclusive results in so far as determining any best date of seeding was concerned. An instance is recorded of winter wheat seeded as late as November 1st making an average yield of 22.2 bushels for five years with no failure in any year. Wheat seeded September 16th made a four year average of 25.8 bushels.

Mr. Cecil Salmon, now of the Kansas Experiment Station, who had direct charge of the winter grain experiments at Newell from 1908 to 1913 inclusive, concluded that there is no "best date" to seed but it is best if possible to seed soon after a rain so as to insure moisture near enough to the surface to germinate the seeds quickly and uniformly.

TABLE XX.

TIME OF SEEDING TEST ON TURKEY C. I. NO. 3055 WINTER WHEAT AT BELLE FOURCHE STATION.

Date of Seeding	1908		1909		1910		1913		1914		Average	
	Grain Bus.	Straw Cwt	Grain Bus.	Straw Cwt	Grain Bus.	Straw Cwt	Grain Bus.	Straw Cwt	Grain Bus.	Straw Cwt	No. Years	Bushels
Aug. 1	Not sown						29.2	30.7	Not sown		1	
Aug. 16	Not sown		37.5	27.3	19.3	28.4	28.1	27.8	Not sown		3	28.3
Sept. 1	23.0	21.2	39.0	33.6	8.3	9.5	28.1	27.5	Not sown		4	24.6
Sept. 16	20.3	19.8	40.5	32.7	22.0	29.3	Not sown		20.2	21.0	4	25.8
Oct. 1	24.3	22.4	43.0	34.2	0.0	0.0	28.1	26.1	21.1	18.0	5	23.3
Oct. 16	24.7	25.6	42.0	39.0	13.3	16.5	21.4	20.0	20.7	17.2	5	24.4
Nov. 1	25.3	23.7	37.3	33.6	13.2	22.6	16.3	20.4	19.1	20.0	5	22.2
Nov. 16	Not sown						16.1	16.3	Not sown		1	16.1

(c) September 20th.

AVAILABLE BULLETINS

105. Stock Foods for Pigs.
106. Sugar Beets in South Dakota.
107. Sheep Scab.
108. New Hybrid Fruits.
109. Rusts of Cereals and other Plants.
111. A Study of South Dakota Butter with Suggestions for Improvement.
112. The Killing of Mustard and other Noxious Weeds in Grain Fields by the Use of Iron Sulphate.
113. Progress in Variety tests of Barley.
114. Digestion Coefficients of Grain and Fodders for South Dakota.
115. Report of Work for 1907 and 1908 at Highmore Sub-Station.
116. Acidity of Creamery Butter and its Relation to Quality.
117. Sugar Beets in South Dakota.
123. Milk Powder Starters in Creameries.
125. Fattening Steers of Different Ages.
126. Alkali Soils.
127. Breeding and Feeding Sheep.
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