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South Dakota State University Agricultural Experiment Station

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Forage Plants and Cereals at the Highmore Sub-Station for 1904-5

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Bulletin 96 March, 1906

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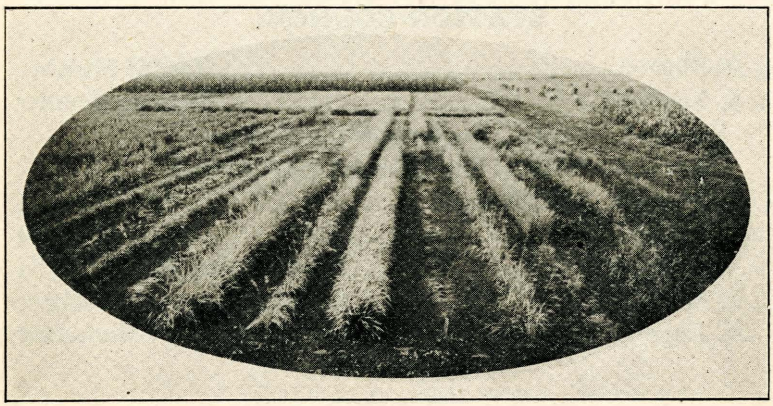

GRASS NURSERY

Forage Plants and Cereals

At Highmore Sub-Station

1904-5

DEPARTMENTS OF BOTANY AND AGRONOMY

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FORAGE PLANTS AT HIGHMORE SUB-STATION FOR 1904-5

W. A. Wheeler Sylvester Balz

The State Agricultural Experiment Station at Highmore, Hyde county, South Dakota, has been in operation for seven years. This Station was established here because of the advantages of the location in testing and developing drouth resistant crops. Hyde county is fairly representative of a large portion of the state from the James river west, which is not well represented by the Brookings Station. The primary purpose of the Highmore Station was to test and develop grasses and forage crops, as it was supposed that this region would be largely a grass country instead of a farming country. Later developments have shown it desirable and in fact necessary to enlarge somewhat upon the work as it was first planned. Co-operative work with the United States Department of Agriculture in the testing of varieties of cereals has been carried on for three years. The report of this work as given by Mr. John S. Cole forms the latter part of this bulletin.

The experimental farm at Highmore consists of 117 acres of land. The character of the soil and the lay of the land is somewhat poorer than the average in Hyde county. This, however, is not a disadvantage, for on this account no one can consider the records from the Highmore Station as coming from an unusually good piece of land and, therefore, unreliable for general comparisons.

The conditions of soil and climate that one has to deal with at this Station are similar to those that are found in the counties of Faulk, Potter, Sully, Hughes, Hyde, Hand, Buffalo, Jerauld, Brule, Aurora, and western Beadle county. It would be impossible to locate one station the soil of which would be absolutely representative of a territory as large as this,

but the general climatic conditions throughout this region, as well as larger portions west of the Missouri river, are well represented at Highmore.

The past three years in which the work of the Highmore Station has been carried on have been in general satisfactory. 1903 was a good year for nearly all crops. 1904 was favorable to the maturity of early crops and small grains, but the late drouth destroyed most all of the later crops. The season of 1905 was unusually wet, the rainfall being over twenty-five inches, which exceeds all past records for a single season. There is a general impression that this change in climatic conditions is a permanent one. There is, however, absolutely no reason for considering it so, as there have been no continental modifications to bring such a change about, and local conditions are entirely inadequate to account for a permanent change of climate.

Table I gives a record of the rainfall at the Highmore Station so far as it has been observed by Mr. S. Drew, the local weather observer at this point. The observations as given in this table were furnished by the office of the Weather Bureau, Huron, South Dakota. The record for some months is missing, but the data given are very instructive. A column has been added, giving the amount of precipitation for the growing season from April to August, as well as for the entire year. A few totals for this period have been brought into this column with the August record missing. These, however, do not change the average materially. A comparison of the available moisture for growing crops can better be obtained from this column than from that giving the annual precipitation.

Up to 1905 the experimental work carried on at the Station was of a more or less general nature to determine what kinds of crops would succeed in this region, and also to make variety tests to determine in general what varieties might be depended upon. In the spring of 1905 a number of experiments in the selecting and breeding of plants were inaugurated. Plants which had stood the test of the conditions at Highmore were largely used as a foundation in starting the breeding work. The crops to which special attention is to

Table I

Giving precipitation in inches for the Highmore Station so far as it has been recorded to date.

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual Precipitation	Precipitation Growing Season April-Aug.
1888	.....	.....	.....	.....	.....	.....	5.79	3.10	.....	.....	.....	.....	.....	.....
1889	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1890	.....	.....	0.30	0.19	0.83	6.17	0.36	0.56	0.45	0.32	0.30	.....	.....	8.11
1891	.....	Trace	0.83	1.94	.....	.....	0.72	0.80	.....	.....	.....	.....	.....	.....
1892	.....	.....	.....	.....	.....	.....	1.20	1.17	1.10	0.75	0.20	0.20	.....	.....
1893	0.15	0.15	.....	3.85	1.90	2.55	2.64	.....	Trace	.....	.....	.....	.....	10.94
1894	0.45	0.05	2.20	0.98	0.33	5.91	0.42	0.01	0.10	1.63	Trace	Trace	12.08	7.65
1895	0.20	Trace	0.74	2.08	1.66	3.73	0.86	1.06	0.70	0.22	1.15	.....	12.40	9.39
1896	Trace	0.30	0.85	2.50	0.95	2.28	6.67	.....	.....	.....	.....	.....	.....	12.40
1897	.....	0.80	2.57	3.44	1.86	2.79	3.75	.....	0.41	1.16	0.48	0.40	.....	11.84
1898	Trace	0.01	1.40	1.51	4.17	1.67	2.33	0.62	.....	.....	.....	.....	.....	10.30
1899	0.45	0.15	1.50	2.00	3.75	4.20	1.81	2.19	0.48	0.84	0.03	0.27	17.67	13.95
1900	Trace	0.06	1.75	3.20	0.47	2.53	2.69	7.56	4.39	.....	.....	0.32	.....	16.45
1901	0.30	0.05	0.60	1.00	0.72	5.93	2.68	2.34	3.93	.....	.....	.....	.....	12.67
1902	.....	.....	.....	.....	.....	.....	.....	3.20	0.40	0.20	.....	1.10	.....	.....
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	15.08	10.46
1904	0.15	0.17	0.05	1.43	0.99	2.25	2.40	1.48	0.38	0.60	Trace	0.60	10.50	8.55
1905	0.60	Trace	0.60	1.39	5.23	5.64	5.54	3.56	0.56	1.95	1.29	Trace	26.36	21.36
Ave.	0.20	0.16	1.10	1.87	1.82	3.74	2.72	2.15	1.34	0.83	0.46	0.39	15.68	11.85

Trace—An amount less than 0.01 inch.

be given in breeding are the alfalfas, millets, sorghums, corn, grasses and annual leguminous plants. Other plants may be added to this list from time to time as they appear to be able to adapt themselves to the conditions.

In addition to the plant breeding work, eight series of three year rotations were started in the spring of 1905, making twenty-four plots in all. In the fall of 1905 sixteen plots were also prepared for the test of different methods of tillage as compared with alternate cropping and summer-fallowing. The crops to be used in these tillage experiments are corn, wheat, barley and oats. Plans have recently been made by which at the beginning of the coming season a block of ninety-four one-tenth acre plots will be used for rotation and tillage experiments in co-operation with the division of dry land agriculture of the United States Department of Agriculture. This line of work is very much needed in the region represented by the Highmore Station. In dry regions proper rotations are doubly valuable, for not only are they important in the maintaining of soil fertility, but they are especially important in conserving the soil moisture.

As the rotation series have just been started, no results of importance have yet been secured. Valuable conclusions cannot be reached until the series have gone at least one round of the crops in the rotation.

The work of the Station has been seriously handicapped for the past three years by the inadequate buildings and equipment of the Station. The work cannot be enlarged or improved to any great extent until new buildings and equipment are secured. Thousands of varieties and selections of seeds grown during the past year are stored in a shed where they are likely to be destroyed by pests, or lost at any time. With the extent of the work as it is at present and the methods that have to be used, several times the labor to secure results is necessary than would be needed with better facilities. The building that is needed above all others is a seed house for the storing and handling of seeds and plants. This building should also include storage room for small tools and machinery and a sleeping room for the superintendent. A threshing shed, wagon scale, a well, and addi-

tional stable facilities are also badly needed in order that the work may go along without hinderance.

It is earnestly desired that the next legislature make some provision for new buildings and other needed equipment for the Highmore Station.

ALFALFA

In the experiments conducted at the Highmore Station during the past seven years, no perennial forage plant has shown up to better advantage than alfalfa. It has shown itself to be capable of resisting extremes of drouth and cold. The varieties of alfalfa from northern sources are naturally not so susceptible to injury during severe winters as are varieties from the south. Some varieties are also showing themselves more resistant to drouth than others. Under all conditions that prevail alfalfa seems to give as good or better results than any other perennial forage plant.

In 1889 five one-fourth acre plots were sown to Turkestan alfalfa distributed by the United States Department of Agriculture under S. P. I. No. 991. The seed of this alfalfa was originally obtained from the province of Tashkend by Professor N. E. Hansen on his exploration tour in 1898. Three of these plots were destroyed in the building of a barn on the Station grounds. Two plots remain, and are at the present time in better condition than they have ever been before.

This variety of alfalfa has shown itself capable of giving a hay crop whenever conditions for a short period of time have been favorable to the growth of the plant. When the rainfall has been moderate during the early part of the season and drouth has prevailed during the latter part, one good or fair early crop of alfalfa has been secured. When the moisture is insufficient early in the season and plentiful later, a late crop has been cut. In 1903 and 1905, with comparatively favorable conditions throughout the season, two crops were obtained. Apparently none of the plants of this variety have

been killed by severe cold or by severe drouth. All the plants in the field seem to be in a strong and healthy condition after the seven years' test.

From plot B5 of alfalfa in 1903, the first cutting, made June 27th, yielded at the rate of 2,080 pounds of hay per acre. The second cutting, made August 9th, yielded at the rate of 980 pounds per acre, making a total yield for the season of one ton and 1,060 pounds per acre. In 1904 the same plot, because of late drouth, was cut only once for hay. The yield for this early crop was 1,672 pounds per acre. In 1905, with the soil very dry in the spring, but with an unusual amount

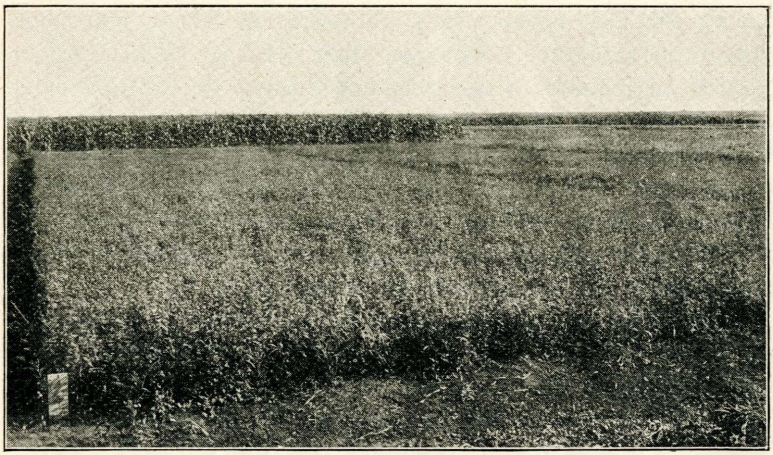

Fig. 1—Alfalfa, Oasis S. P. I. No. 12846
Showing second growth 10 inches high, from photograph taken August 19, 1905.

of rainfall during the growing season, two good crops were cut. The first crop was taken June 23d at an average height of one foot and ten inches. The yield for this plot of one-fourth acre was 537 pounds, or at the rate of one ton and 148 pounds per acre. The second cutting was made August 7th, with plants about two feet and eight inches in height. This second crop was very much heavier than the first crop, because of the soil having received a large amount of rainfall and the plants having recovered from the dry fall and spring of 1904 and 1905. The hay from this crop was largely de-

stroyed by storm and rain, which very materially lessened the weight. The hay from this cutting weighed 335 pounds per plot, or at the rate of 1,412 pounds per acre. The plot for the year gave a yield of one ton and 1,560 pounds per acre, not taking into account the large loss to the second crop by storm, which was estimated to be about one-third of the entire second cutting. A good growth was made after the second cutting, but it was not thought best to cut it so late in the season.

Several other plots of Turkestan, Samarkand and French alfalfa were sown between 1899 and 1901, but they were not grown in such a way as to give a comparison between them and the above mentioned variety. All of the others have either been killed out by severe winters or plowed up because of a poor stand. In 1905 five one-tenth acre plots of alfalfa were sown to five different kinds of alfalfa obtained from the United States Department of Agriculture. The record for these five plots is given in Table II. Nineteen square-rod plots were also sown in 1905 to alfalfa from various sources.

Table II

Giving record for the first year from seed of five varieties of alfalfa sown May 12, 1905. The hay contained about one-fifth pigeon grass.

Accession Number	Variety	U. S. Dep't of Agriculture S. P. I. Number	Height when Cut July 22d	Yield of Hay per Acre
200	Montana	12747	1 ft. 2 in.	1850 lbs.
201	Oasis (Fig. 1)	12846	1 ft. 4 in.	1930 lbs.
202	Arabian	12992	1 ft. 1 in.	1620 lbs.
203	Turkestan	13436	1 ft. 2 in.	1720 lbs.
204	Tripoli	12847	1 ft. 5 in.	1630 lbs.
	Average all varieties		1 ft. 3 in.	1750 lbs.

In 1904 a large number of square-rod plots of grasses, clovers and other forage plants were sown, and among these were about thirty plots of alfalfa. There were also other plots in which alfalfa formed a part of the various mixtures. Owing to the late drouth this year, very few of the grasses and clovers, although most of the alfalfas, survived. One one-

fourth acre plot was sown to a mixture of all the grass and clover seeds remaining after sowing over 200 square-rod plots. In this mixture there were twenty-eight different kinds. Various kinds of alfalfa made up about one-fifth of the mixture. This plot in the fall of 1904 showed a good stand of alfalfa, with very few other plants showing in the plot. On August 23, 1905, the hay from this plot, made up of about two-thirds of alfalfa, was cut, and yielded hay at the rate of one ton and 164 pounds per acre.

These facts go to show the drouth resistance and hardiness of alfalfa in general and especially of the Turkestan variety S. P. I. No. 991.

Plant breeding work with alfalfa was taken up in the spring of 1905. Selection rows of eleven different kinds were sown and kept under observation during the season. These rows were sown three feet apart and the plants were only a foot apart in the row. About 130 plants of each kind were under observation. From the eleven varieties about 150 plants were selected and seed saved separately from the individual plants for sowing in 1906. In these selection rows it appeared that varieties of alfalfa from Turkestan sources varied more in the character of the plant than did those from American or southern European sources. The Turkestan alfalfa showed a larger percenage of coarse, shrubby plants than the others. There were, however, a large number of desirable plants, and it is hoped that from these selections can be made and one or more desirable hardy varieties bred for our conditions.

In seed production a great variation in the individual plants appeared. In no case, however, were there any plants which failed to give any seed when the soil was cultivated around them. The question of seed production with alfalfa is one that should receive considerable attention. In all experiments conducted by the writer, it appeared that the seed is produced much more freely and of much better quality by alfalfa under cultivation than when grown in the ordinary manner.

Insect visitation may have considerable to do with seed production in alfalfa. Insects, by their visits, effect a rupture of the keel of the flower, thus scattering the pollen over

the stigma. If the body of the insect at the time of its visit bears foreign pollen, as it very likely would if it had previously visited other alfalfa flowers, the stigma would be dusted with foreign pollen as well as by the pollen from the same plant. The amount of cross and self-pollination then probably depends largely upon the potency of the two kinds of pollen. The butterflies seem to predominate among the insects visiting alfalfa flowers. When alfalfa is in bloom they hover over the field in large numbers.

RED CLOVER

In taking up red clover for testing at the Highmore Station, one is touching upon quite a new field for this particular region. Red clover is not supposed to be a very drouth resistant crop. However, in the testing of red clover at the Brookings Station, it has been observed that there is a very great difference in the various strains of red clover in drouth resistance and hardiness. It may be possible to develop a clover which will occupy a place in dry land agriculture. No extensive experiments have been started with red clover, but it has been taken up rather cautiously and systematically, so that whatever results are obtained will be of lasting benefit. So far only those red clovers that have given good results at Brookings and have stood the test of hardiness for the past five years, have been used in the experimental work at Highmore.

In the red clover plots the first year from seed it appears from the growth of the plants that the soil is inoculated with clover bacteria in small patches, and that there are larger areas which are not inoculated. The writer has come to the conclusion that the small patches of clover making a good growth and showing tubercles upon the roots, have been inoculated from the seed that was sown. It is thought that such inoculation, where these patches are of sufficient number and scattered, will spread through the plots in the course of a short time.

On account of the excessive rainfall the past season, the stand of clover for the season was very good. By having a good stand to start with, any dry years that may follow will give a good test of the drouth resistance of these clovers. Thirteen square-rod plots and seventeen selection rows were planted in 1905 from seed raised at Brookings in 1904 and from a few other sources.

MILLETS

A number of varieties of millets have been tried at the Highmore Station during the past six years. Some of these have given good results. The barnyard millets do not seem to be of high enough quality to warrant much further trial, and the pearl millets sold under the name of Pencillaria and other names are too late for our seasons. The broom corn or proso millets and the foxtail millets have given good results, and the trials with them will be continued. The former are earlier maturing and more drouth resistant than the latter. On account of their rapid growth and drouth resistance they are becoming popular in the semi-arid region. On account of their larger seed they are considered as grain producers, and not as a forage crop. The foxtail millets, however, are much more leafy and produce a much better quality of forage than the broom corn millets, but are not considered to be as drouth resistant. This may be due in part to their longer season of growth. The broom corn millets mature in from 75 to 85 days, and the foxtail millets require from 85 to 110 days. A larger number of varieties of foxtail millets are sold by seedsmen than of the broom corn millets, because of their having been grown much more extensively. The varieties of the former class are sold under the names of German, Hungarian, Siberian, Common, etc. The varieties of the latter group have been largely imported during recent years from foreign countries by the United States Department of Agriculture. They have been distributed under the names of White Ural, Red Lump, Black Voronezh, Red Russian, Red Voronezh, etc.

The season of 1904 was so very dry during July and August that none of the millets produced a crop worthy of mention. The broom corn millets matured a small crop of seed, but none of the foxtail millets ripened. The total amount of dry matter produced per acre with the five varieties of each class was about the same. In 1905 good crops from all millets under trial were secured. The large amount of moisture, however, favored the foxtail millets. With the broom corn millets, when a large amount of moisture is present, the weeds usually obtain the upper hand, as these millets are not strong

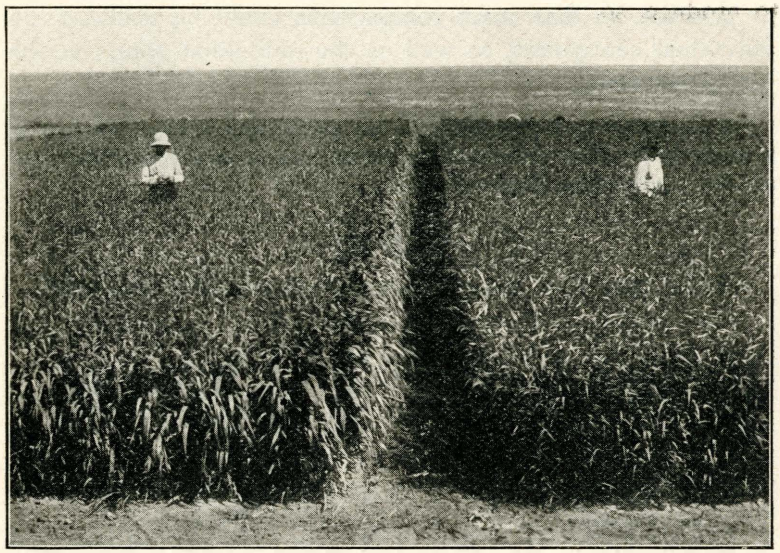

Fig. 2—Plots G6, German Millet, and G5, Hungarian Millet
From photograph taken August 19, 1905.

enough growers to crowd the weeds out. The common or foxtail millets prefer more moisture, but there is a great difference in the varieties in this respect.

Tables III and IV give the record of the millets in one-tenth and one-fourth acre plots for 1904 and 1905. These are merely records of individual plot yields and were not intended to give an exact comparison of varieties. Wherever varieties were grown on adjoining plots which can be determined from the table by the plot numbers, a rough compari-

son of the yields from the different varieties may be made.

Plant breeding work was begun with the foxtail millets in 1904. A number of selections of individual plants were made from the varieties of millets grown that season. The product of each individual plant was sown in a centgener* in 1905. Over 200 centgener rows were sown this year from the individual selections. Each row contained in all about 130 plants, but only the 100 plants in the middle of each row were used for the centgener record. The rows were two feet apart and the plants six inches apart in the row. These were grown under as nearly uniform conditions as it was possible to produce, so that exact comparisons could be made of the individual centgeners, as well as the individual plants in the centgener rows.

*** A centgener is a generation of 100 plants grown from the seed of a single plant. The 100 plants are usually grown in a row or plot with all the plants equal distances apart.**

Table III

Giving record of broom corn millets for 1904 and 1905.

Year	Name of Variety	Number of Plot	Height of Plants	Yield of Straw per Acre	Yield of Seed per Acre
1904	Red Orenburg.....	D 4	1 ft. 4 in.	1860 lbs.	1 bu. 24 lbs.
	Red Russian	D 5	1 ft. 5 in.	1884 lbs.	2 bu. 36 lbs.
	Black Voronezh.....	D 6	1 ft. 5 in.	1332 lbs.	1 bu. 8 lbs.
	Red Orenburg.....	E 3	1 ft. 4 in.	1080 lbs.	2 bu. 17 lbs.
	S. P. I. 10625.....	E 4	1 ft. 4 in.	1620 lbs.	0 bu. 42 lbs.
1904	Average		1 ft. 4 in.	1555 lbs.	1 bu. 35 lbs.
1905	Black Voronezh.....	A 3	4 ft. 3 in.	3075 lbs.	33 bu. 36 lbs.
	Red Orenburg.....	A 5	2 ft. 9 in.	2350 lbs.	21 bu. 42 lbs.
	Red Russian.....	A 6	3 ft. 2 in.	2630 lbs.	42 bu. 14 lbs.
	Red Orenburg.....	B 19	2 ft. 4 in.	2328 lbs.	27 bu. 32 lbs.
	Red Russian.....	B 20		2232 lbs.	23 bu. 22 lbs.
	Black Voronezh.....	D 17	3 ft. 10 in.	3380 lbs.	29 bu. 28 lbs.
1905	Average		3 ft. 3 in.	2666 lbs.	29 bu. 37 lbs.

Table IV

Giving record of foxtail millets for 1904 and 1905.

Year	Name of Variety	Plot Number	Height	Total Yield per Acre when Cut for Hay	Yield of Straw per Acre when Cut for Seed	Yield of Seed per Acre
1904	Siberian	C 11	1 ft. 0 in.	1336 lbs.		
	Hungarian	C 12	1 ft. 1 in.	1860 lbs.		
	German	C 13	1 ft. 1 in.	1788 lbs.		
	Common	C 14	0 ft. 11 in.	1312 lbs.		
1904	Average		1 ft. ¼ in.	1574 lbs.		
1905	Kursk	A 4	3 ft. 4 in.		4740 lbs.	54 bu. 8 lbs.
	Siberian	G 3	3 ft. 10 in.		7540 lbs.	53 bu. 2 lbs.
	Common	G 4	3 ft. 2 in.		6690 lbs.	52 bu. 34 lbs.
	Hungarian* ..	G 5	3 ft. 10 in.		5770 lbs.	37 bu. 44 lbs.
	German*	G 6	4 ft. 4 in.	8560 lbs.		
	Siberian	C 1	2 ft. 10 in.	6628 lbs.		
	Common	C 2	2 ft. 10 in.	5052 lbs.		
	German	C 3	3 ft. 4 in.	7924 lbs.		
1905	Average		3 ft. 5 in.	7041 lbs.	6185 lbs.	49 bu. 22 lbs.

From field observation forty-seven centgeners were selected for plot test in 1906. The record for these centgeners is given in table V.

* Fig. II.

Table V

Giving record of selected centgeners of millets for 1905.

Accession No. of Variety	Name of Variety	Number of Centgener	Number Days Required to Mature	Total Weight of 100 Plants	Weight of Grain from 100 Plants
78	Kursk, light.....	13	99	15 lbs. 8 oz.	6 lbs. 11 oz.
78	Kursk, light.....	15	99	16 lbs. 10 oz.	6 lbs. 5 oz.
78	Kursk, light.....	17	99	16 lbs. 8 oz.	6 lbs. 10 oz.
78	Kursk, light.....	23	99	17 lbs. 0 oz.	6 lbs. 0 oz.
78	Kursk, light.....	32	99	16 lbs. 15 oz.	6 lbs. 9 oz.
78	Kursk, light.....	33	99	13 lbs. 14 oz.	5 lbs. 0 oz.
78	Kursk, light.....	34	98	16 lbs. 0 oz.	6 lbs. 9 oz.
78	Average.....		99	16 lbs. 1 oz.	6 lbs. 4 oz.
79	Kursk, dark.....	3	93	18 lbs. 5 oz.	7 lbs. 5 oz.
79	Kursk, dark.....	10	101	20 lbs. 10 oz.	8 lbs. 4 oz.
79	Kursk, dark.....	15	91	17 lbs. 12 oz.	7 lbs. 9 oz.
79	Kursk, dark.....	17	91	18 lbs. 0 oz.	7 lbs. 12 oz.
79	Kursk, dark.....	22	91	17 lbs. 0 oz.	7 lbs. 8 oz.
79	Kursk, dark.....	24	94	17 lbs. 8 oz.	6 lbs. 13 oz.
79	Kursk, dark.....	34	92	20 lbs. 0 oz.	7 lbs. 15 oz.
79	Average.....		93	18 lbs. 7 oz.	7 lbs. 9 oz.

Table V—Continued

Accession No. of Variety	Name of Variety	Number of Centgener	Number Days Required to Mature	Total Weight of 100 Plants	Weight of Grain from 100 Plants
80	Kursk	5	95	20 lbs. 5 oz.	7 lbs. 3 oz.
80	Kursk	7	95	12 lbs. 12 oz.	4 lbs. 2 oz.
80	Kursk	13	97	17 lbs. 8 oz.	6 lbs. 10 oz.
80	Kursk	22	99	18 lbs. 12 oz.	6 lbs. 13 oz.
80	Kursk	24	98	15 lbs. 8 oz.	6 lbs. 11 oz.
80	Kursk	25	98	16 lbs. 4 oz.	6 lbs. 0 oz.
80	Kursk	26	98	17 lbs. 3 oz.	6 lbs. 12 oz.
80	Kursk	27	98	18 lbs. 14 oz.	7 lbs. 8 oz.
80	Average		97	17 lbs. 2 oz.	6 lbs. 7 oz.
81	Common	8	99	16 lbs. 9 oz.	6 lbs. 6 oz.
81	Common	12	98	18 lbs. 0 oz.	7 lbs. 0 oz.
81	Common	13	99	15 lbs. 0 oz.	5 lbs. 14 oz.
81	Common	17	98	15 lbs. 11 oz.	5 lbs. 0 oz.
81	Common	21	99	18 lbs. 12 oz.	7 lbs. 0 oz.
81	Common	24	102	18 lbs. 0 oz.	6 lbs. 0 oz.
81	Common	27	99	18 lbs. 7 oz.	6 lbs. 3 oz.
81	Common	29	99	16 lbs. 14 oz.	5 lbs. 14 oz.
81	Average		99	17 lbs. 3 oz.	6 lbs. 2 oz.
82	German	1	103	20 lbs. 0 oz.	7 lbs. 2 oz.
82	German	4	106	19 lbs. 7 oz.	5 lbs. 14 oz.
82	German	10		24 lbs. 1 oz.	6 lbs. 14 oz.
82	German	15	103	22 lbs. 3 oz.	6 lbs. 2 oz.
82	German	17	102	18 lbs. 14 oz.	5 lbs. 1 oz.
82	German	19	103	20 lbs. 0 oz.	5 lbs. 15 oz.
82	Average		103	20 lbs. 12 oz.	6 lbs. 3 oz.
83	Hungarian	9	106	18 lbs. 8 oz.	6 lbs. 15 oz.
83	Hungarian	10	88	18 lbs. 8 oz.	6 lbs. 10 oz.
83	Hungarian	13	106	19 lbs. 6 oz.	6 lbs. 14 oz.
83	Hungarian	14	106	18 lbs. 0 oz.	7 lbs. 3 oz.
83	Average		102	18 lbs. 9 oz.	6 lbs. 14 oz.
84	Siberian	2	99	16 lbs. 15 oz.	6 lbs. 5 oz.
84	Siberian	6	99	16 lbs. 8 oz.	6 lbs. 8 oz.
84	Siberian	9	96	13 lbs. 8 oz.	5 lbs. 8 oz.
84	Siberian	20	99	18 lbs. 0 oz.	7 lbs. 4 oz.
84	Siberian	26	96	16 lbs. 15 oz.	6 lbs. 11 oz.
84	Siberian	28	100	17 lbs. 12 oz.	6 lbs. 6 oz.
84	Siberian	31	97	16 lbs. 1 oz.	6 lbs. 13 oz.
84	Average		98	16 lbs. 8 oz.	6 lbs. 8 oz.

Table VI—Millets

General summary of centgener averages according to variety.

Accession No. of Variety	Name of Variety	Number Days Required to Mature	Total Weight of 100 Plants	Weight of Grain from 100 Plants
78	Kursk, light	99	16 lbs. 1 oz.	6 lbs. 4 oz.
79	Kursk, dark	93	18 lbs. 7 oz.	7 lbs. 9 oz.
80	Kursk	97	17 lbs. 2 oz.	6 lbs. 7 oz.
81	Common	99	17 lbs. 3 oz.	6 lbs. 2 oz.
82	German	103	20 lbs. 12 oz.	6 lbs. 3 oz.
83	Hungarian	102	18 lbs. 9 oz.	6 lbs. 14 oz.
84	Siberian	98	16 lbs. 8 oz.	6 lbs. 8 oz.
	Average all varieties	99	17 lbs. 13 oz.	6 lbs. 9 oz.

From this table it will be seen that there is a general uniformity in the whole record of centgeners for each variety, but that there are prominent exceptions. Some of these exceptions, especially where they are very marked, are probably due to mixtures of other varieties in the sowing from which the original selections were made. Each centgener is pure in itself, as it traces back to the individual plant selection in 1904. From table VI, giving a general summary of the centgener records, a general idea can be gained of the average time required for growth, total weight of 100 plants, and the weight of the grain from 100 plants for the seven varieties grown. This table shows that for 1905 millet No. 79, known as the dark grained Kursk millet, has the record for early maturity, as well as the record for the largest amount of seed produced per 100 plants. In total weight of plants it ranks third. No centgener record of drouth resistance could be made the past year on account of the excessive rainfall, but it has been observed in dry years that the Kursk millets were the least susceptible to drouth of any of the varieties of foxtail millets tried at the Highmore station.

Kursk millet No. 2798 was imported by the United States Department of Agriculture and distributed by the division of seed and plant introduction. Both the Brookings and the Highmore Stations have grown it for several years. In 1904 the light and dark seeded kinds were separated for plant

breeding work and were given Highmore accession numbers 78 and 79. From the record it will be seen that No. 78 light and No. 79 dark are different millets in many characteristics. Kursk millet No. 80 has probably been grown from the same importation, but has never been separated into light and dark. It is largely a dark grain variety, but does not show early maturity nor the yield of No. 79 dark.

The product of each of these forty-seven centgeners will be used to sow a one-twentieth acre field plot in 1906, so that comparative yields of hay may be obtained under field conditions. A few of those which appear in this record as the most desirable will also be sown in seed plots, so that in case their record continues to be good they may be increased and distributed for trial throughout the state in a few years.

For plant breeding work a much more complete record is kept in the department for reference, giving very complete data for each centgener as to time of heading, blooming and ripening, as well as the character and texture of the leaves, color of head, etc., but only the record giving yield and time required to mature for the forty-seven selected centgeners is given in this table.

The plant breeding work with broom corn millets has only been begun. Selection rows from which individual plants were selected were grown in 1905. These will be increased to centgeners in 1906. Records can be given of these after further work.

GRASSES

During the seven years that the experiment work at the Station has been in progress a large number of introduced and native grasses have been tried. Very few of them have given any results worthy of mention. Those that have already been tried and have given good results or at least have proved themselves worthy of further trial, are Bromus inermis or Russian brome grass, Slender wheat-grass, western wheat-grass, wild rye-grass and wild timothy.

Bromus inermis has shown some good qualities. The seed

will germinate and the young plants will grow under conditions which would destroy most grasses. During the first few years it will produce good crops of hay under ordinary conditions. It does far better, however, on a rather moist soil than on dry soil. Under very dry conditions it will not produce much of a hay crop. Three or four years after seeding it usually becomes somewhat sod-bound and should be plowed under or perhaps used as pasture for a few years longer.

The seed of the Bromus inermis from thirty or forty different sources has been tried at the Station and quite a differ-

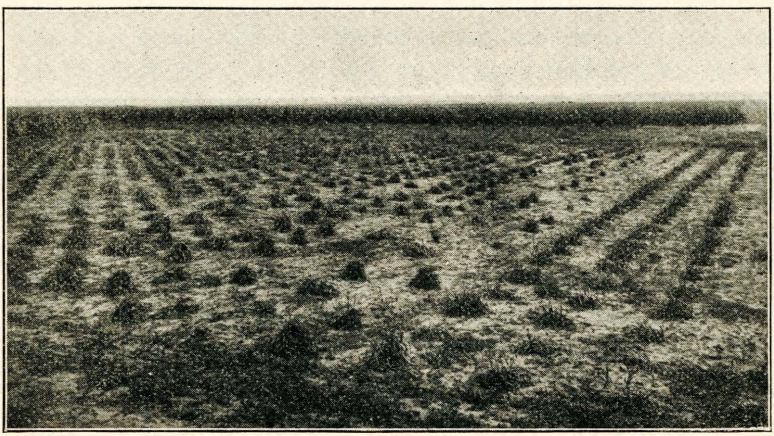

Fig. 3—Bromus Inermis
Selection plots, taken August 19, 1905, the first year from seed, showing manner of growing for study of individual plants.

ence has been noted in the character of the plants from the different lots of seed. Whether any of these variations will prove more valuable than others for general culture remains yet to be determined. Selection plots have been sown from seed from the different sources, so that individual plants may be kept under observation. In these plots (Fig. 3) the seed is sown in hills in much the same manner as corn, three feet eight inches apart each way. The plants in the hills are thinned to one plant to each hill. In this way the individual plants can be studied and selections based on desirable characteristics can be made. It is not known yet whether these first selections will come true to the type or not.

Bromus inermis and alfalfa, when sown together on the Station grounds, as well as elsewhere, have given promise of good results. Accurate information, however, as to comparative yields cannot be given.

Slender wheat-grass (Agropyron tenerum) has been grown at the Station since 1899, and some good results have been secured. The plants have stood the test of severe drouth and severe winters without injury, and a good stand can be secured under ordinary conditions. The grass makes good quality of hay, which can be easily handled. From the record of Slender wheat-grass up to the present time, it is doubtful whether it would prove profitable to occupy land that has been broken and subdued for other crops with this grass. A one-fourth acre plot (B21) has been occupied by Slender wheat-grass for five years. For the first two years no hay was cut. During the last three years one crop has been cut each year. The yields from this plot for the years 1903, 1904 and 1905 are respectively 980 pounds, 908 pounds and 1,920 pounds per acre.

The wild rye-grass (Elymus canadensis) has given results similar to those secured by the Slender wheat-grass. The hay is not of so good a quality, but the yield is somewhat greater. Both of the above grasses have given results sufficient to warrant their further trial and selection.

A one-fourth acre plot (B19) was sown to wild rye-grass in 1903. Hay was cut on this plot in 1904 and 1905. The yields from this plot for the two years are respectively 1,168 pounds and 2,170 pounds per acre.

The western wheat-grass or the alkali grass of the range country, gives promise of being a good grass under cultivation as well as on the native prairie. It produces as good or better quality of hay than any of the other native grasses. No record of yields from plots have yet been obtained.

A grass nursery (see figure on front cover) was started in the spring of 1905, and in this nursery were sown seeds collected by the writer on a trip from Pierre to the Black Hills by way of the Cheyenne river, and also samples of grass seeds secured from other sources. From the desirable kinds

in the nursery rows, the seed will be saved and sown in larger plots. About 100 collections of seeds, mostly from native grasses, were sown in the grass nursery in 1905.

CORN

On account of the drouth during the months of July and August in 1904, practically no corn matured at the Station, so no yields can be recorded. In 1905 experiments were conducted to compare some of the varieties of northern grown corn. Eleven varieties were under observation in this variety test. Table VIII gives the record of results from this test. The varieties were planted in duplicate series. Owing to the ravages of gophers and the corn-ear worm, the yields were very materially lowered. A very accurate comparison of varieties can, therefore, hardly be made from the results.

The early part of the season of 1905 was very backward and it was thought that corn would not mature. The latter part of the season was, however, so favorable to the growth of corn and the frosts held off to such a late date that all but one variety matured well. This variety, from Springfield, required from ten to fifteen days longer to mature than did the others. The record of the yield as given in the table is hardly comparable with the other records because of the greater amount of moisture in the ears at the time the weights were taken. This corn is much too late for the latitude of Highmore under ordinary conditions, but would probably do very well 100 or 150 miles south.

Of the early maturing varieties, the Minnesota No. 13, originated by the Minnesota Experiment Station, gave the largest yield and produced the best quality of corn of any in the test. This corn shows results of good breeding. It was more uniform in character than any other corn tried. The stalks are about uniform in height. The height of the ears from the ground did not vary nearly so much with this variety as with the others. Practically every stalk produced a fair ear. Even though this variety gave the best results this

year, the characteristics of the kernel and ear can undoubtedly be very greatly improved by continued further selection. It is far from being a perfect corn, but seems to be the best early maturing corn that has been tried at this latitude and under these conditions. In the series of rotation plots there were four one-tenth acre plots of Minnesota No. 13 corn which yielded on an average forty-six bushels per acre. Besides the plots of this corn under trial, a field of about seven acres was planted. In all about 400 bushels of Minnesota No. 13 were gathered. From this about 100 bushels were selected for seed, and this seed has been sold throughout the state in one, two and four bushel lots at $2 per bushel.

A one-fourth acre plot of flint corn planted May 25th ripened September 26th, and yielded at the rate of sixty-four bushels per acre. This plot was not so seriously damaged by the gophers and corn-ear worm as were the plots in the variety test.

Table VII

Giving record of results from variety test with corn.

Accession Number	Name of Variety and Source of Seed	Average Height of Plants	Average Height of Ears from Ground	Average Number Days Required to Mature	Series I				Series II				Average Yield per Acre, Both Series
					Date of Planting	Average Time of Ripening	Yield per Plot in Pounds	Yield per Acre in Bushels at 75 Pounds per Bushel	Date of Planting	Average Time of Ripening	Yield per Plot in Pounds	Yield per Acre in Bushels at 75 Pounds per Bushel	
		ft in	ft in					bu lbs				bu lbs	bu lbs
278	Minnesota No. 13 (Experiment Station, Brookings)	7 0	3 0	119	May 19	Sept. 15	455	46 0	May 20	Sept. 16	444	44 67	45 33
336	Pride of the North (Geo. Spurrell, Springfield, S. D.)	8 6	3 8	134	May 19	Oct. 1	497	50 18	May 20	Oct. 1	494	49 71	50 7
99	Minnesota King (Northrup, King & Co.)	6 0	1 6	127	May 19	Sept. 23	230	23 19	May 20	Sept. 24	176	17 63	20 41
100	Minnesota Yellow Dent (Northrup, King & Co.)	6 10	2 8	124	May 19	Sept. 20	312	31 41	May 20	Sept. 20	339	34 19	32 68
97	Strawberry Dent (Northrup, King & Co.)	6 8	2 0	125	May 19	Sept. 20	174	14 69	May 20	Sept. 23	194	19 32	17 13
98	Northwestern Dent (Northrup, King & Co.)	6 0	1 8	119	May 19	Sept. 22	157	15 65	May 20	Sept. 22	180	18 15	17 3
96	Rustler White Dent (Northrup, King & Co.)	6 8	2 0	126	May 19	Sept. 15	303	30 47	May 20	Sept. 15	283	28 46	29 47
160	Montana Earliest (John A. Salzer Seed Co.)	5 6	1 4	118	May 20	Sept. 15	338	34 5	May 20	Sept. 15	329	33 90	33 45
337	Yellow Dent (Experiment Station, Highmore)	6 4	1 10	117	May 20	Sept. 15	404	40 63	May 22	Sept. 15	428	43 20	42 4
338	Loveland Dent (Experiment Station, Highmore)	6 4	2 2	117	May 20	Sept. 15	416	42 4	May 22	Sept. 15	438	44 21	43 13
339	Early Huron Dent (Experiment Station, Highmore)	7 8	3 4	127	May 20	Sept. 25	420	42 35	May 22	Sept. 25	438	44 21	43 28

Table VIII

Giving data from twenty ears of corn, Minnesota No. 13, grown in 1905 and selected for breeding purposes.

No. of Ear	Length of Ear	Weight of Ear	Per Cent Shelled Corn to Ear
1	8 inches	9 3/8 ounces	83.3 per cent
2	8 inches	9 3/8 ounces	84.7 per cent
3	8 inches	8 11-16 ounces	86.3 per cent
4	8 inches	8 3/4 ounces	84.3 per cent
5	8 1/4 inches	9 ounces	82.7 per cent
6	7 1/2 inches	9 7/8 ounces	82.3 per cent
7	7 1/2 inches	8 1/2 ounces	83.8 per cent
8	7 1/2 inches	8 1/4 ounces	84.5 per cent
9	7 3/4 inches	9 3/8 ounces	83.3 per cent
10	7 1/2 inches	8 1/4 ounces	85.6 per cent
11	7 3/4 inches	8 1/4 ounces	85.6 per cent
12	7 inches	8 3/8 ounces	83.6 per cent
13	7 1/4 inches	8 3/4 ounces	82.4 per cent
14	7 inches	8 ounces	87.7 per cent
15	7 1/2 inches	8 5/8 ounces	81.7 per cent
16	7 1/4 inches	7 3/4 ounces	85.5 per cent
17	7 inches	8 7/8 ounces	80.0 per cent
18	7 1/4 inches	7 3/8 ounces	82.0 per cent
19	7 inches	8 1/8 ounces	80.0 per cent
20	7 inches	7 5/8 ounces	80.0 per cent
Ave.	7 1/2 inches	8 1/2 ounces	83.4 per cent

SORGHUMS

Sorghums have been grown at the Highmore Station for the past three years. Most varieties require too long a season to mature for this location. In favorable seasons some of the earlier varieties ripen, but ordinarily they are green at the time of the first frost. They produce a large amount of fodder, which is usually of excellent quality.

In 1904 all varieties of sorghum were a failure because of the late drouth. In 1905 a large amount of fodder was produced and a crop of seed from some of the varieties. The record for the year is given in table IX. The earliest variety grown at Highmore to date is the one listed as Montana No. 341. This has been grown at the Station for several years, and matures when others fail.

Table IX

Giving Record of Sorghums for 1905

Accession Number	Variety	Number of Plot	Date of Sowing	Height	Yield of Fodder per Acre
	Branching Doura.....	A 2	June 3	6 ft. 0 in.	5 tons 1132 lbs.
157	Kaffir	C 5	May 20	6 ft. 0 in.	4 tons 10 lbs.
137	Minnesota Early Amber..	C 6	May 20	9 ft. 6 in.	4 tons 32 lbs.
341	Montana	E 10	May 22	9 ft. 8 in.	6 tons 88 lbs.
159	Salzer's Earliest.....	E 11	May 22	9 ft. 0 in.	6 tons 864 lbs.
	Average all varieties..			8 ft. 0 in.	5 tons 425 lbs.

CEREAL INVESTIGATIONS AT HIGHMORE

John S. Cole Sylvester Balz

In the spring of 1901 the South Dakota Experiment Station entered into an agreement with the Bureau of Plant Industry of the United States Department of Agriculture to co-operate with the Department in grain investigation. Under this agreement the work was to be carried on at Brookings and at one other place farther west in the state. The Experiment Station agreed to furnish land, teams, machinery and labor, the Department to furnish seed and bear a portion of the expense.

"In this co-operative agreement Dr. A. F. Woods of the Bureau of Plant Industry was given general supervision of the work for the Department of Agriculture, and the work at this Station was placed in charge of Professor E. C. Chilcott, agriculturist of this Station. Professor Chilcott was commissioned collaborator by the Secretary of Agriculture, and Mr. John S. Cole, a senior student of the College, was appointed special agent of the Department of Agriculture and detailed to assist Professor Chilcott in the co-operative work at Brookings. Mr. Sylvester Balz was assigned to a similar position at Mellette, where a duplicate set of experiments was carried on in order to ascertain whether the conditions in these somewhat widely separate parts of the state would materially affect the results obtained. Mr. M. A. Carleton, cerealist of the United States Department of agriculture, has attended to

the details of this co-operative work on the part of the department at Washington."*

This personnel remained practically the same until June 30, 1905, when Professor Chilcott resigned to accept a position with the Department of Agriculture.

In the spring of 1903 the work which had been carried on at Mellette for two years was transferred to Highmore, where the state already maintained a sub-station, for the investigation of drought-resistant forage plants and grasses. Mr. Balz, in addition to his position as special agent of the Department of Agriculture, was made superintendent of the Highmore Sub-station.

The work at Highmore has been in part supplemental to, and in part a duplication of, the extensive work with cereals being carried on at Brookings under the same co-operative agreement. The limited funds and equipment has made it necessary for the present to confine the work chiefly to testing new varieties of grain that we have believed to be adapted to the western portion of that part of the state east of the Missouri river. But while this has been the main line of investigations, it has been found possible to combine with it some experiments in cultural methods and seed selection, and a good start has been made toward purifying and improving the best varieties. But this latter is necessarily a second stage in crop improvement. The first problem in any locality is to find what are the best varieties for that locality among those that are already available.

Attention has been as yet centered very closely on the more prominent of the newly introduced drought-resistant grains, and particularly upon durum or macaroni wheat. From 80 to 100 varieties of grain have been grown each year in uniform sized plats of one-tenth acre each, under conditions as nearly comparable as may be.

The results for the year 1903 have already been published in bulletin No. 84, but they are included in this report. Conditions in the early spring of 1903 were favorable for a good start and a vigorous growth of all kinds of grain. The rainfall during April, May, and up to the 24th of June was very light. Before the heavy rain on the latter date small grains

* S. Dak. Bul. 77.

were in a critical condition. Most varieties were heading close to the ground, stools were generally killed, and some of the earliest varieties of barley were ripening prematurely. One effect of this dry weather in the early part of the growing season was to produce a small growth of straw. Besides this, early varieties were so far advanced before the rain came that recovery with them was less complete than with late varieties.

Conditions in 1904 were very similar, dry weather in the early part of the season, with considerable moisture immediately preceding harvest. The result in both years was the same: a light growth of straw, which filled so well that it produced a good crop of grain of wonderfully good quality. The epidemic of rust which was so general over the northwest that year did but very little damage at Highmore. Only a few susceptible varieties were damaged to an appreciable extent.

1905 was a year of abundant moisture, well distributed and of just about the right amount to produce a maximum crop of grain of first class quality.

DURUM WHEAT

About one-half of the total number of plats of grain at Highmore for the three years under consideration have been devoted to variety tests of durum wheat. This may appear to be an undue proportion to devote to one crop, but it must be remembered that while it was already known about what to expect from the common varieties of grain, that durum wheat was practically a new crop, which we had reason to believe possessed a high degree of adaptation for that section of the state in which Highmore is located. Many varieties of this wheat of widely different characteristics had been imported or found growing in scattered localities in the northwest, and the importance which this crop was assuming made the determination of the relative values of these varieties a matter of the first importance.

Forty-nine varieties of this wheat have been under trial at Highmore, nearly all of them for the full period of three years. The yields of these varities, in bushels per acre, are given in the accompanying table number 1.

In 1903 the yield ranged from 9 bushels to 20.2 bushels per acre, with an average of 14.9 bushels for the whole number.

In 1904 the yield ranged from 8.2 bushels to 23.8 bushels per acre, with an average 14.7 bushels.

In 1905 the lowest yield was 20.8 bushels, and the highest 38.7 bushels, with an average for the whole number of 28.6 bushels per acre.

Fig. 4. 1905 Wheat Crop at the Highmore Station

It will be noted that the yields vary with the varying seasons, so that no one variety stands out strongly above all the rest. But as the same varieties have been under trial at other places, our knowledge of them is so complete that we can with a great deal of confidence pick the best varieties. Into this selection of varieties for final value, must enter also our knowledge of their milling properties and the behavior of the manufactured product in the hands of the baker or in

the macaroni factory. These points have already been determined and published by the department of chemistry of this Station.

Table No. 1

Variety Tests of Durum Wheat at Highmore

Number and Name	Bushels per Acre			
	1903	1904	1905	Aver.
1354—Kubanka	12.8	20.3	27.0	20.0
1516—Kubanka	10.7	23.3	28.5	20.8
1541—Kubanka	10.0	23.2	26.7	20.0
1440-5639—Kubanka	15.2	23.8	23.2	20.7
2094-8212—Kubanka	16.7	23.3	26.5	22.2
2234-8213—Kubanka	13.5	22.3	24.3	20.0
1490—Kubanka	.....	.....	25.5	.....
1350—Pererodka	15.9	21.2	28.3	21.8
1515—Pererodka	16.3	18.2	21.7	18.7
1377—Realforte	16.0	17.2	24.7	19.3
1428—Egyptian	18.8	19.0	23.2	20.3
1431—Arnautka	19.3	.....	.....	.....
1537—Arnautka	16.2	18.0	36.0	23.4
———Arnautka	.....	.....	36.7	.....
1481—Bledur	16.5	18.7	25.3	20.2
1483—Bledur	18.5	.....	.....	.....
1508—Bledur	16.5	13.8	24.5	18.3
1509—Bledur	16.0	17.2	31.3	21.2
1510—Bledur	17.2	16.0	30.8	21.3
1492—Nicaragua	18.8	14.7	24.5	19.3
1493—Wild Goose	17.8	16.8	38.7	24.4
1513—Beloturka	14.0	12.3	35.8	20.7
1520-5800—Beloturka	12.0	9.5	.....	.....
1540—Chernokoloska	12.8	13.0	34.2	20.0
1546—Gharnovka	16.0	12.8	25.0	17.9
1443-5643—Gharnovka	15.5	13.5	24.2	17.7
1447-5646—Gharnovka	14.7	11.8	24.0	16.8
1444-5642—Yellow Gharnovka	18.7	11.3	25.2	18.4
2096-8230—Yellow Gharnovka	19.2	10.5	26.7	18.8
1445-5644—Velvet Don	18.8	12.5	27.2	19.5
1446-5645—Black Don	16.5	9.3	.....	.....
2100-8232—Black Don	11.7	10.2	.....	.....
1381-5492—Medeah	12.0	10.0	.....	.....
1597-7579—Medeah	14.0	11.0	31.8	18.9
1567-5352—Novo-Rossisk	13.6	11.0	29.5	18.0
1568-5353—Algerian	13.7	8.2	.....	.....
1569-5354—Argentina	17.1	10.7	33.3	20.4
1570-5355—Taganrog	18.5	13.3	35.0	22.3
1586-5351—Berdiansk	15.8	12.7	33.0	20.5
1584-5380—Pellisier	17.7	14.0	20.8	17.5
1593-7578—Marouni	11.7	14.0	29.2	18.3
1594-7580—Adjini	10.7	11.0	29.2	17.3
1595-7581—Kahla	11.3	11.3	35.8	19.5
2088-7794—Kahla	9.0	13.7	32.0	17.9
2086-7785—Pellissier	20.2	12.3	22.3	18.3
2087-7793—Mohamed	11.8	14.7	36.8	21.1
2089-7795—Richi	12.1	.....	.....	.....
2099-7792—Mahmoudi	14.2	.....	.....	.....
2228-9130—Saragolla	11.2	11.7	25.5	16.1
Average	14.9	14.7	28.6	.....

Taking all these things into consideration, the ten following varieties can be very safely picked as the ones that are worthy of further trial:

Table No. 2

Average Yield of Ten Best Varieties of Durum Wheat

Number and Name	Average Yield per Acre for Three Years
1493—Wild Goose	24.4 bushels
1537—Arnautka	23.4 bushels
2094-8212—Kubanka	22.2 bushels
1350—Pererodka	21.8 bushels
1516—Kubanka	20.8 bushels
1440-5639—Kubanka	20.7 bushels
1513—Beloturka	20.7 bushels
1354—Kubanka	20.0 bushels
1541—Kubanka	20.0 bushels
Arnautka*	.... bushels

* 1905 was the first year at Highmore for this variety.

It might appear from the above yields that the Kubanka variety is not worthy of the recommendation it has had, but in so far they are somewhat misleading. Its yield, while not the best, is still good, it gives a good yield of flour of the best quality, and is the only pure variety of good quality that has as yet been available in any amount. The strains of Wild Goose and Arnautka that are taking the lead in point of yield are varieties that have been purified by selection in our plats and increased from small amounts. Their value is only beginning to be known. They are more rust and disease resistant than the Kubanka, and can be successfully grown in localities or seasons too wet for that variety. But it will be at least two years yet before any of them are available in amounts sufficiently large for distribution. In the meantime Kubanka may be considered the best variety that is available for general growth.

The greater number of the varieties that have been imported come from sections where agricultural methods and machinery are primitive and crude. Nearly all of the varieties are more or less mixed, and from these mixtures some very promising selections have been made.

While it has been quite generally recognized that macaroni wheat could be successfully grown in localities and seasons too dry to give the best results for bread wheat, the public has not been so quick to appreciate the fact that it is only in such localities and seasons that they give the best results. When the rainfall is too heavy this grain makes too rank a growth of straw and succumbs to attacks of rust, scab and other fungous diseases. In 1904 at Highmore only one of the forty-nine varieties under trial tested less than sixty

pounds per bushel, while at Brookings the same year, of the same varieties with about the same average yield, but one variety tested as much as sixty pounds per bushel.

COMMON BREAD WHEATS

In 1903 there were but two varieties of bread wheat under trial at Highmore. These two, which we found to be practically the same thing, are very drought-resistant and their yield was nearly as much as the average of the durum wheats, but only about two-thirds as much as the best varieties of the durum wheats. But these two varieties rust very easily, and in 1904 the yield of the one that was retained went down to eight bushels per acre. Minnesota No. 169 and Pedigree Blue Stem were added to the list in 1904. Their yield was about two-thirds that of the durum varieties. In 1905 six other standard varieties of bread wheat were added to the list. The best yield of any variety in this group of wheats was 25.5 bushels, while the best yield of durum wheat grown under exactly the same conditions, was 38.7 bushels per acre.

The best yield of common wheat in 1905, both at Brookings and at Highmore, was from the so-called Red Fife, a hard, red, bearded wheat. This was the first year that we had grown this variety. The seed was obtained from Mr. C. H. Carroll of Miller, where it has been giving a good account of itself for the few years it has been grown there. The origin of this variety, which is also called Golden Fife and Johnson's Early Fife, is somewhat obscure.

The following toble No. 3 gives the yield of common wheat for the three years under consideration:

Table No. 3

Yield of Common or Bread Wheat at Highmore

Number and Name	1903	1904	1905
	bu.	bu.	bu.
1514—Ghirka Spring	15.0	.....	.....
1517—Ghirka Spring	14.0	8.0	21.0
Pedigree Blue Stem	.....	11.8	24.8
Minnesota No. 169 Blue Stem	.....	13.1	23.1
Minnesota No. 66 Fife	.....	.....	20.5
Minnesota No. 51 Blue Stem	.....	.....	22.8
Minnesota No. 171 Fife	.....	.....	22.3
Minnesota No. 185 Bearded	.....	.....	22.8
Okanogon Valley Blue Stem	.....	.....	23.3
Red Fife Bearded	.....	.....	25.5
Average	14.5	10.9	22.9

BARLEY

A total of thirty-one varieties of barley have been grown at Highmore. The greater number of these have been of the two-rowed type, the Minnesota No. 6, a pedigreed strain of Manchuria barley, being now the only representative of the common type of barley.

Five varieties were a total failure the first year. From year to year the poorer ones have been thrown out and new varieties added, so the number under trial each year has remained about the same.

Table No. 4

Variety Tests of Barley at Highmore

Number and Name	Bushels per Acre			
	1903	1904	1905	Aver.
23—Chevalier	12.1	11.0	.....	.....
35—Chevalier	16.4	14.8	45.6	25.6
24—Hanna	19.4	17.5	50.6	29.2
26—Hanna	15.8	16.4	45.0	25.7
28—Hanna	15.6	10.8	43.9	23.4
30—Hanna	13.1	23.5	32.7	23.1
33—Hanna	12.3	15.4	40.2	23.0
5793—Hanna	14.4	15.2	53.5	27.7
27—Bohemian	16.4	12.3	46.8	25.2
32—Bohemian	18.3	10.4	54.1	27.6
29—Bestehorn Imperial	12.3	10.0	.....	.....
31—Horn	14.4	12.7	54.4	27.2
34—Hanna Pedigree	15.6	11.0	51.6	26.1
39—Rokaku Chevalier	15.8	.....	.....	.....
47—Striegum	15.6	13.1	47.9	25.5
48—Golden Melon	10.6	10.4	51.0	24.0
50—Tanikaze	00.0	.....	.....	.....
54—Santoku	00.0	.....	.....	.....
52—Shiro Nishiki	00.0	.....	.....	.....
62—Doitsu	12.1	20.8	36.6	23.2
72—Cape	00.0	.....	.....	.....
7583—Beldi	00.0	.....	.....	.....
7969—White	16.4	16.6	45.4	26.1
7970—Black	24.6	.....	40.8	.....
Minnesota No. 6	27.0	16.8	37.7	27.2
Minnesota No. 105	20.6	.....	.....	.....
25—Saale	.....	.....	42.7	.....
10583	.....	.....	40.8	.....
10584	.....	.....	48.5	.....
10585	.....	.....	41.8	.....
10586	.....	.....	40.0	.....

It will be seen by the accompanying table that results are somewhat conflicting, but in point of average yield Hanna No. 24 and Hanna No. 5793 are as yet in the lead. In 1903 Minnesota No. 6 stood at the head of the list, but in 1904, a somewhat similar season, it fell to fourth place, and in 1905, a year of heavy production, it was entirely outclassed by the two-rowed barley.

The two-rowed barleys are likely to prove a very valuable addition to our list of farm crops. The best varieties of this species of barley are persistently out-yielding the best varieties of the common type of barley, both at Brookings and at Highmore. Besides their heavy yield, the grain is heavier, plumper and has a better color; they make a nicer bundle, and are not so disagreeable to handle as the common barley. We are not yet pushing their introduction into general cultivation for two reasons: First, we are not entirely satisfied as to the merits of the different varieties of this group; and second, there are some objections to it on the market.

Our experience shows that so far we have no variety of barley that can successfully compete in a dry year with drought-resistant grains, such as macaroni wheat, Swedish Select oats, emmer and hog millet.

OATS

There have been under trial each year about six varieties of oats. This number will be largely increased the coming season. The following table shows the results that have been obtained:

Table No. 5

Yield of Oats at Highmore

Number and Name	Bushels Per Acre			
	1903	1904	1905	Aver.
Sixty Day	24.0	41.2	64.0	43.1
Swedish Select	38.1	54.4	55.0	49.2
Tobolsk	36.5	.....	42.8	.....
5513—North Finnish, black	35.3	.....	53.4	.....
5059*	.....	.....	.....	.....
4344—Black Hungarian	23.7	.....	.....	.....
286—Red Algerian	.....	.....	60.3	.....
10264—Belyak	.....	.....	52.5	.....

The leading varieties are the Sixty Day and Swedish Select. These have been grown and distributed by the Station for a number of years.

It will be noted that in the years 1903 and 1904 the Swedish Select gave the best yield, but that in 1905 it was exceeded

by the Sixty Day. The relative merits of the Red Algerian and Belyak are as yet unknown, as 1905 was their first year under trial at Highmore.

The Swedish Select is a medium sized, short, plump, white oat, that ordinarily weighs about 38 pounds per bushel. It is medium maturing, produces a fair growth of stiff leafy straw and stands very high as a drought-resistant grain. Originally from Sweden, it has been grown in Russia for many years, and was imported from there by the United States Department of Agriculture in the spring of 1899. It is now thoroughly established all over the northwest. In Wisconsin it has stood at the head of their list for several years, and has been distributed in that state as Wisconsin No. 4. It was distributed in this state by the State Experiment Station in 1901. In 1902 a more extensive distribution was made, and every year since several hundred bushels have been sold to farmers by the Station. In the western part of the state it has made a good crop in years when the common varieties were a total failure, but in the eastern and southeastern portions of the state in years of excessive moisture it is likely to grow too rank and to be damaged by rust. It is no more subject to damage in this way, however, than are all common varieties of oats.

The Sixty Day oat, originally from Russia, was imported by the United States Department of Agriculture in 1901. It was first distributed by the Experiment Station in 1902, and this distribution has been continued each year since. With only two exceptions, every farmer to whom we have sold this oat is still growing it and is much pleased with it. It is similar to the Kherson oat, which has been a marked success in Nebraska, but it is adapted to a section somewhat farther north than that variety. In North Dakota the Sixty Day oat has headed the list of varieties under trial for the last three years.

It is a small yellowish oat that weighs about 34 pounds per bushel. The hull is very thin, being easily shelled off in threshing if the concaves are set too close. It does not mature in sixty days, as many infer from the name, but it is a very early oat, ripening fully two weeks earlier than Blue Stem wheat. As its growth of straw is small and strong, it

can be grown on very rich land with very little danger of lodging. It ripens early enough to escape all danger from rust, a disease that usually causes a large loss in the oat crop. These two factors, together with its drought-resistance, makes it an almost sure crop. Its strongest point is its heavy yield under nearly all conditions. Farmers all over the state report yields from 45 to 85 bushels per acre from this oat.

The possible increase in the value of the oat crop in this state through the thorough introduction of these two varieties alone is hard to estimate.

EMMER OR SPELT

Three varieties or strains of this grain have been grown at Highmore. The following table shows the results that have been obtained:

Table No. 6

Yield of Emmer at Highmore

Number and Name	Pounds per Acre			
	1903	1904	1905	Aver.
1524	1030	1660	2410	1700
South Dakota No. 3	880	.....	2100	.....
1526	.....	.....	2210	.....

No. 1524, which is the variety commonly grown in the state, appears to be somewhat the best of the three. Its average yield for the three years has been 1,700 pounds per acre.

In 1905 a plat of Einkorn, a grain somewhat similar to emmer, was grown, and gave a yield of 2,410 pounds per acre.

WINTER GRAINS

In the fall of 1904 about one-half acre each of winter wheat and winter rye were sown in corn ground. The wheat was a strain of the hard Turkey Red winter wheat commonly grown in northern Kansas, Nebraska and Iowa. This seed came to us from northern Iowa, and had been grown at Brookings for four years. The rye was Minnesota No. 1, a hardy variety

improved and sent out by the Minnesota Experiment Station, but which had been grown at Brookings for two years.

The following winter and spring were very dry. Conditions in fact were about as unfavorable as could be imagined for the growth of winter grain. The wheat was badly winter-killed, but the rye came through in good condition with a nearly perfect stand. The yield of rye was 25.7 bushels per acre and of wheat 6.8 bushels.

Hardy varieties of rye offer considerable promise for this section of the country, but it was hardly expected that even the most hardy varieties of wheat would be able to stand the dry, cold winter.

EFFECTS OF THE IMMEDIATELY PRECEDING CROP ON THE YIELD OF GRAIN IN AN UNFAVORABLE SEASON

In 1903 three pieces of land, each eight rods wide, lying side by side and separated only by roads one rod wide, were cropped as follows: One was in wheat, the second was in corn, and the third was summer-fallowed. Previously to 1903 all had had about the same treatment. The land that grew wheat was plowed to a fair depth, about five inches, about the middle of the plowing season in the fall. The ground was then left rough until spring, when it was well dragged immediately before seeding. The corn was well cultivated and kept free from weeds, and produced a crop of about 25 bushels per acre. In the spring one-half of the corn ground was plowed and dragged, and the other half was disked, but at no time during the season could there be seen any difference in the crops growing on each half. The other piece of ground produced no crop at all in 1903. It lay in stubble until the first of July, when it was plowed about six inches deep, turning under a fair growth of green stuff. The ground at that time was dry and rolled up very rough and lumpy, but it was not touched until it was dragged before seeding the following spring.

Right across these three series of land thus prepared, skipping only the roads, was sown two varieties of durum wheat, two varieties of Blue stem, one of emmer, Swedish Select oats,

Sixty Day oats, Minnesota No. 6 barley, and a variety of two-rowed barley. The sowing was done with a disc drill. A strip two rods wide was sown of each variety of grain, thus making one-tenth of an acre of each kind of grain on each kind of land.

We had then nine varieties of grain, all well adapted to their environment, and each sown on land prepared in the three different ways, with all conditions the same except the treatment the land had had in the matter of the preceding crop. The following table No. 7 gives the resulting yields in bushels per acre:

Table No. 7

Table Showing the Effects of the Immediately Preceding Crop on the Yield of Grain in 1904.

Crop on Land in 1903	Wheat	Corn	Fallow
Crop in 1904	Yield per Acre		
	bu.	bu.	bu.
5642—Yellow Gharnovka	2.7	17.8	9.3
5639—Kubanka	2.3	16.7	9.5
Pedigree Blue Stem	00.0	11.8	8.8
Minnesota No. 169	00.0	13.2	8.3
1524—Emmer	3.0	36.9	32.2
Swedish Select oat	1.4	48.1	54.4
Sixty Day oat	3.3	33.4	41.2
Minnesota No. 6 barley	00.0	19.3	16.9
24—Hanna barley	00.0	23.3	17.5

As has been previously noted, and as is shown in the table of precipitation in the first part of this bulletin, the season of 1904 at Highmore was very dry, the rainfall for the five growing months being 8.55 inches, which is the least amount that has been recorded for the same months in any year since 1894.

As a result of the dry weather, everything was a total failure on the land that had grown a crop of small grain the year before. A few of the better plats were mowed and threshed out from one to three bushels per acre, but there was nothing that could have been gathered with the ordinary harvesting machinery, and nothing that any farmer would ever think of harvesting.

On the land that had been in corn the year before, separated from the latter plats only by a road a rod wide, sown with the same drill, same seed, and at the same time, we harvested a reasonably good crop of all kinds of grain. The straw was of just about the right height to handle nicely with the binder, and the quality of the grain was wonderfully good, as it nearly always is in dry sections.

On the summer-fallowed land lying next to the corn ground, and with all conditions the same again except the preparation of the land, the crop was fairly good, but with the exception of the two varities of oats was not as good as on the corn ground. Just why the oats should have been better on the summer fallow than on the corn ground is hard to understand. If the summer-fallow had been dragged immediately after plowing and as often thereafter as the surface became packed and hardened, thus maintaining a loose surface mulch to conserve the moisture in the soil, it is probable that the yield of all the grains on the land so treated would have been as good as they were on the corn ground.

All our experience goes to prove that as good a crop of grain can be grown following a well tended crop of corn as can be grown after the best summer-fallow. In fact, we have some very strong evidence now to prove that the fertility and crop-producing powers of the soil are maintained longer by a system of alternate cropping to corn than they are by a system of summer-fallowing. Leaving the soil bare during the hot and usually dry summer season burns out the humus in the soil faster than it is removed from the same soil by a growing crop.

This instance of small grain being a total failure when grown after small grain in a dry year, while at the same time a good crop was produced after corn is not an isolated case, but is the general rule. In fact, it is becoming so well known that in some sections of both this and other states with similar climatic conditions farmers make a practice of planting half their land to corn or some other cultivated crop every year, and never think of sowing small grain after small grain. It is the introduction of such practices as this, with their attendant good results, together with the introduction of varieties of grain adapted to the conditions of soil and climate,

that lends color to the more or less general belief that the climate is undergoing a permanent change.

HEAVY VS. LIGHT SEED WHEAT IN 1905

In connection with the variety tests in 1905, several experiments were made at both Brookings and Highmore to determine something of the relative value of different grades of wheat for seed. Light and heavy seed of each of four varieties of wheat were grown at Brookings and of three varieties at Highmore. At Brookings two of the varieties were bread wheat and two were macaroni wheat; at Highmore two were macaroni wheat and one was bread wheat.

The heavier seed came up the quicker, with a stronger and more vigorous plant, and stooled the quicker. About the time they were stooled the difference in the crop from the two grades of seed could be seen almost as far as could the fields themselves. Later in the season conditions were very favorable for the production of a good crop of grain, and the grain from the lighter seed made up something of this early difference. But in every case but one the heavier seed gave the heavier yield. This one exception was 1516 Kubanka at Highmore, where the heavier seed weighed 64 pounds and the lighter seed 60 pounds per bushel. With the same seed at Brookings the heavier grade produced 1.3 bushels more per acre than the lighter grade. The greatest difference was 7.4 bushels per acre in the case of 1377 Realforte durum wheat at Highmore.

Averaging all seven trials, there was a difference of 2.17 bushels per acre in the crop from an average difference of 14.3 pounds per bushel in the weight of the seed.

In some cases, particularly with macaroni wheat at Brookings, the lighter weight seed produced a heavier crop of straw, but a lighter yield of grain than did the heavier seed. This was undoubtedly due to the fact that the crop from the poorer seed was later and did not fill as well as did the crop from the better seed. Other things being equal, the earlier the wheat is the better it fills in an average season. The fol-

lowing table number 8 gives the detailed results of this experiment:

Table No. 8

Heavy versus Light Seed Wheat in 1905

Variety Number and Name	Place of Experiment	Weight per Bushel of Seed	Yield		Weight of Crop per Bushel
			Straw Tons	Grain Bushels	
1377—Realforte	Brookings	62.0	.890	13.7	48.5
1377—Realforte	Brookings	42.5	.935	10.5	48.5
1377—Realforte	Highmore	62.0	1.735	24.7	56.0
1377—Realforte	Highmore	42.5	1.480	17.3	55.5
1516—Kubanka	Brookings	64.0	.875	20.8	56.5
1516—Kubanka	Brookings	60.0	.940	19.5	57.0
1516—Kubanka	Highmore	64.0	1.375	28.5	60.0
1516—Kubanka	Highmore	60.9	1.445	29.7	60.0
1517—Ghirka	Brookings	53.0	.910	11.3	57.0
1517—Ghirka	Brookings	37.0	.885	9.7	59.0
South Dakota Climax	Brookings	60.0	1.175	19.2	60.0
South Dakota Climax	Brookings	40.0	.890	17.8	59.0
Okanogon Valley	Highmore	55.0	1.515	23.3	56.0
Okanogon Valley	Highmore	38.0	1.560	21.8	55.0