1-1-1919

Barley Culture in South Dakota

Manley Champlin

J.D. Morrison

J. Martin

BULLETIN NO. 183 JANUARY, 1919

AGRICULTURAL EXPERIMENT STATION

In Co-operation with United States Department of Agriculture Bureau of Plant Industry---Cereal Investigations

SOUTH DAKOTA
STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS

AGRONOMY DEPARTMENT

A. N. Hume, Head of Dept.

Barley Culture in South Dakota

BROOKINGS, SOUTH DAKOTA

Bowen Pub. Co. Huron, So. Dak.

GOVERNING BOARD

Hon. T. W. Dwight, President.....Sioux Falls, S. D.
Hon. August Frieberg, Vice-Pres.....Beresford, S. D.
Hon. T. A. Potwin .....Lemmon, S. D.
Hon. Frank Anderson .....Webster, S. D.
Hon. J. W. Campbell .....Huron, S. D.

STATION STAFF

T. W. Dwight .....Regent Member
J. W. Campbell .....Regent Member
Ellwood C. Perisho .....President of College
James W. Wilson....Director and Animal Husbandman
N. E. Hansen .....Vice-Director and Horticulturist
C. Larsen .....Dairy Husbandman
A. N. Hume.....Agronomist and Supt. of Sub-Stations
J. G. Hutton .....Associate Agronomist
Harry C. Severin .....Entomologist
Manley Champlin .....
.....Associate Agronomist and Collaborator
Howard Loomis .....Agronomy Analyst
Mathew Fowlds .....Assistant Agronomist
E. S. McFadden .....Assistant Agronomist
T .H. Wright .....Assistant Dairy Husbandman
Robert Wylie .....Assistant Dairy Husbandman
B. A. Dunbar .....Consulting Chemist
C .C. Lipp .....Consulting Veterinarian
Reginald Sherwood .....Assistant Chemist
R. A. Larson .....Secretary
P. W. Hanson .....Bulletin Clerk and Stenographer

EXPERIMENT FARMS

Brookings .....Brookings County
Cottonwood .....Jackson County
Eureka .....McPherson County
Highmore .....Hyde County
Vivian .....Lyman County

SUMMARY

1. Barley ranks fourth in total production among the cereal crops in South Dakota.

2. Experiments upon which statements in this bulletin are based were conducted at the state college experiment farms at Brookings, Cottonwood, Eureka and Highmore and the U. S. Department of Agriculture experiment farm at Newell.

3. In general, barley has proved to be the highest producing small grain crop, though there have been some notable exceptions.

4. No advantage has been found in growing barley in mixtures with oats or emmer.

5. Odessa S. D. 182 gives good results in all parts of the state where tried and is recommended as the general purpose barley for the state as a whole. Other varieties are recommended for special conditions.

6. Using the best seed obtainable is good practice. Poor seed means poor stands and low yields.

7. Rust, smut, ergot, stripe disease and blight are among the important barley diseases. Control measures include early seeding, seed disinfection and grading and the rotation of crops.

8. Barley responds readily to good rotation methods.

9. The seed bed for barley should be firm with a shallow mulch at the surface.

10. Early seeding is very important. Six pecks per acre is generally the best rate of seeding. The proper depth of seeding is about 2 inches. Seeding with a drill is recommended.

11. Barley can be grown as a cultivated crop to good advantage in sections where corn is not a highly profitable crop.

12. Careful shocking and stacking is strongly recommended in order to secure grain of good market quality.

BARLEY CULTURE IN SOUTH DAKOTA

By Manley Champlin, J. D. Morrison and John Martin.

Importance of the Barley Crop

Barley ranks fourth among the cereal crops grown in South Dakota, being exceeded in total production by corn, wheat and oats. The average value of the barley crop during the last ten years has amounted to over $10,000,000 per annum. South Dakota ranks fourth among the states in barley production, being exceeded by California, Minnesota, and North Dakota. During the last ten years the acreage has been about a million each year. The greatest acreage was reached during 1909, 1910 and 1911. Since then there has been a slight decrease. The average yield of barley in bushels per acre for the five years 1907 to 1911 inclusive was 18.5 bushels as compared with 24.2 bushels for the five years from 1912 to 1916, a difference of 5.7 bushels per acre. It is impossible to say just what proportion of this gain is due to favorable seasonal conditions and what part to improved methods. It seems fair to assume, that at least a part of the gain is due to improved methods of production such as the use of adapted varieties, better graded seed, better rotation of crops, etc.

The statistics as obtained from the U. S. Department of Agriculture Year Books are presented in graphic form in the accompanying diagrams, Figs. 1, 2 and 3. Table 1 presents a comparison of barley and other important crops of the state. This bulletin is published for the purpose of furthering the improvement of the barley crop by the presentation of such information as now exists with reference to the vital factors in barley production including varieties, time and rate of seeding, crop rotation, seed treatment and seed bed preparation.

(1) The experiments reported in this bulletin have been conducted jointly by the South Dakota Experiment Station, Agronomy Department and the U. S. Department of Agriculture, Bureau of Plant Industry, Office of Cereal Investigations under cooperative agreement. The work has been conducted at Brookings, Cottonwood, Eureka, Highmore and Newell. Cecil Salmon and John Martin have had charge of the work at Newell. John S. Cole, Manley Champlin and J. D. Morrison have conducted the investigations at Highmore. The tests at Brookings were begun by E. C. Chilcott and have since been carried on by John S. Cole, Clyde Woodworth, I. S. Oakland and Matthew Fowlds. At Cottonwood the experiments were started by S. W. Sussex and have been continued by R. K. Turner, C. H. Wiser and M. B. Hinsvark. William Herman began the work at Eureka and Frank L. Sutherland has been continuously in charge since 1912. Since 1912 the cereal experiments at all the state experiment farms have been directly supervised by the senior author of this bulletin.

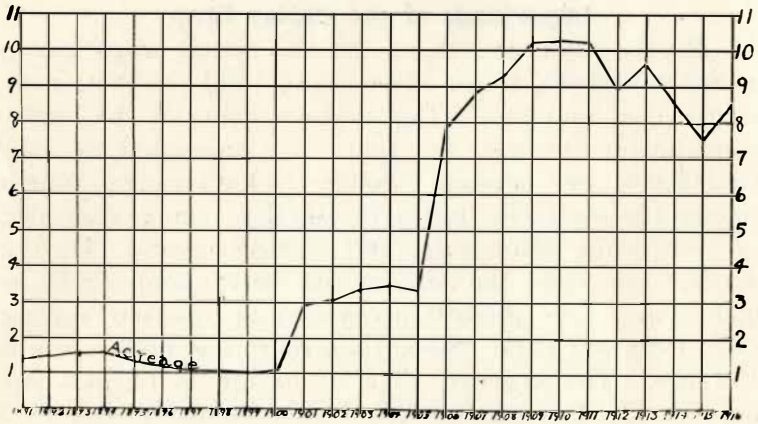

Fig. 1. Diagram showing acreage of barley in South Dakota from 1891 to 1916 inclusive, figures at margin representing hundred thousands of acres.

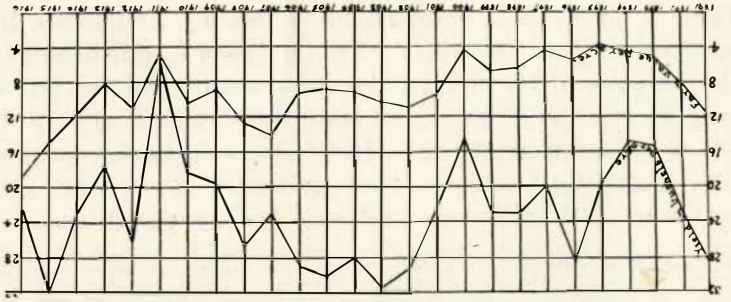

Fig. 2. Diagram showing the farm value per acre on December 1st of each year and the yield per acre of barley in South Dakota from 1891 to 1916 inclusive, figures at margin representing the value per acre of the barley crop in dollars and the yield per acre in bushels.

TABLE I. Acreage, production, farm value, yield and value per acre comparing the first war year 1917, with the acreage for the previous ten years, 1907 to 1916, inclusive.

Crop	Acreage		Production in Bushels		Total Value		Yield per Acre		Farm value per bu. Dec. 1st.		Acre Value Dec. 1st	
	1917	1907-1916	1917	1917-1916	1917	1907-1916	1917	1907-1916	1917	1907-1916	1917	1907-1916
Wheat ..	3,716,000	3,471,900	52,024,000	38,538,090	101,967,000	35,445,043	14.0	11.1	$1.96	$.92	$27.44	$10.21
Corn ...	3,350,000	2,457,500	97,150,000	67,335,500	116,580,000	34,341,105	29.0	27.4	1.20	.51	34.80	13.97
Oats ..	1,925,000	1,566,000	65,450,000	41,968,800	39,924,000	15,108,768	34.0	26.8	.61	.36	20.74	9.65
Barley .	1,020,000	913,900	26,520,000	19,557,460	29,172,000	10,952,177	26.0	21.4	1.10	.56	28.60	11.98
Flax ..	140,000	456,100	980,000	3,831,280	2,930,000	5,900,109	7.0	8.4	2.99	1.54	20.93	12.93
Rye	350,000	61,380	5,600,000	1,018,908	8,680,000	703,046	16.0	16.6	1.55	.69	24.80	11.45

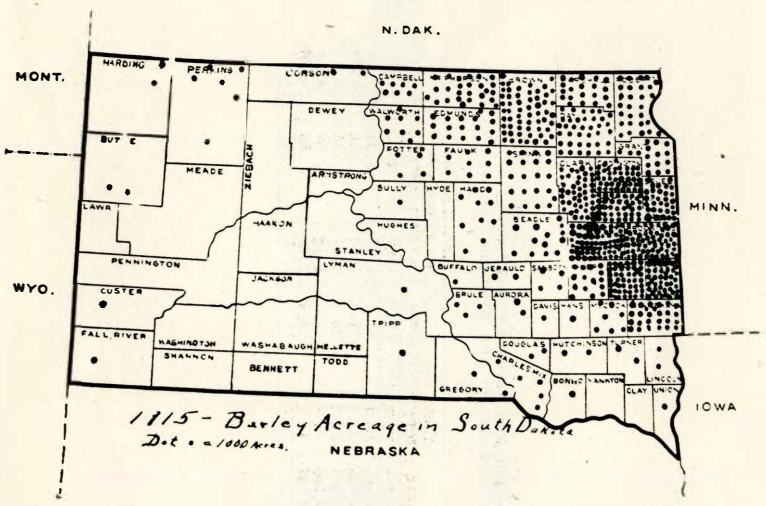

Fig. 3. Map of South Dakota showing distribution of the barley crop. Each dot represents 1,000 acres.

Comparison of Barley with Other Grain Crops

In experiments conducted at Brookings to determine the producing power of barley as compared with other crops for which it might be substituted as feed or food, the results in general have been favorable to barley. During five years 1913 to 1917, barley produced an average yield of 2582 pounds as compared with 1881 for emmer, 2297 for oats and 2490 for rye. In another test where the crops were grown continuously during the years 1908 to 1917 barley produced an average of 1707, oats 1661 and corn 2342 pounds per acre.

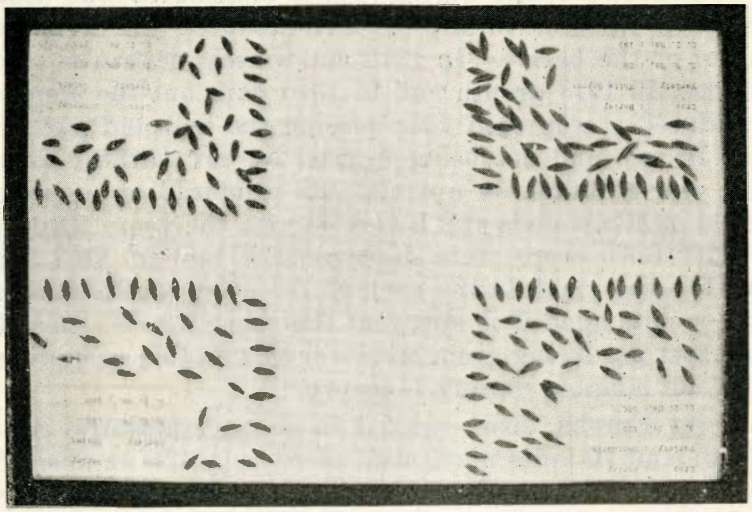

Fig 4. Grain of some leading barley varieties; Manchuria S. D. 105, Odessa S. D. 182, Smyrna S. D. 28 and Gatami S. D. 122.

At Cottonwood farm, located about 95 miles west of Pierre, all of the ordinary crops have been grown two years on summer fallow in comparison with Odessa barley. In this test barley yielded an average of 898, emmer 788, Sixty Day Oats 821, shelled corn 1027, kaoliang 203, millet seed 555 and proso 863 pounds per acre, for the years 1916 and 1917, corn being the only crop which exceeded barley in yield of grain. In a comparison of barley and emmer in three year rotations on an alkali flat in which the barley and emmer followed, corn, kaoliang, and proso which in turn followed sweet clover, the results were in favor of the emmer in all cases. As an average for six years 1912-1917, inclusive, following corn, barley yielded 220 pounds to 350 for emmer. After kaoliang barley produced 289 pounds to 345 for emmer and following proso the result was 296 for barley and 418 for emmer. In these tests Manchuria barley was sown in 1912 and 1913. Then Gatami was substituted as the Manchuria proved to be ill adapted to local conditions.

The two years, during which Manchuria was used resulted in total failures, which reduced the average yield of the barley. In 1912 cut worms destroyed the barley, in 1913 drouth and in 1915 hail, but the emmer produced a crop each year missing the hail and part of the drouth and not being injured by cut worms. In a six year rotation, on upland, oats produced an average yield of 498 pounds and barley 449 for the years 1912 to 1917. Both crops were destroyed by hail in 1915 but made some yield during each of the other years. From the results cited it is apparent that barley ranks among the best producing grain crops for this section providing that an adapted variety is grown.

At Eureka farm, located in the north-central section about 70 miles north west of Aberdeen, a number of tests have been conducted comparing Hannchen barley with oats and emmer, grown in different rotations. In a five year rotation consisting of corn, wheat, sorghum, barley or emmer and sweet clover, the average yield of barley for the years 1912 to 1917 has been 1606 pounds as compared with 1172 pounds of emmer. In a four year rotation, consisting of corn, oats, millet, barley and emmer, barley yielded 1131 pounds and emmer 953 pounds for the same period. In a seven year rotation supplemented with alfalfa, the average for barley was 1572 pounds, for emmer 1392 and 1847 for oats. Thus, the average yield of barley in all tests was 1436 pounds as compared with 1072 pounds of emmer, a gain of 364 pounds.

Where barley and oats have been grown continuously for three years 1915 to 1917 the average results have been 1719 pounds of barley to 1591 pounds of oats. The average gain of barley over oats in both tests has been 107 pounds. It is apparent that barley is the heaviest producing feed grain for this section.

At Highmore farm, located in the central section about 60 miles east of Pierre, White Smyrna barley has been grown in comparison with emmer for 15 years, 1903 to 1917 inclusive. In this test the barley produced 1221,

oats 1224 and emmer 1242 pounds per acre.

As an average of four other tests in which Odessa barley was compared with the same varieties of oats and emmer, during three years 1915 to 1917 inclusive, barley produced an average of 1679, oats 1967 and emmer 1302 pounds. During the three years included in these tests moisture conditions have been reasonably favorable. This may account for the fact that oats have been superior to barley in all tests for the last three years by a considerable margin. This agrees with results at Newell where barley, oats and emmer are compared with and without irrigation. Under irrigation barley yielded 1392, oats 1531 and emmer 1360 pounds. Without irrigation barley led with a yield of 1546 pounds as compared with 1497 pounds for oats and 1278 for emmer.

In most of the tests cited above, barley has yielded more food value per acre than oats or emmer. The exceptions occured under special conditions such as irrigation at Newell and unusually favorable moisture conditions at Highmore which resulted in increased oat yields and accidental or unusual conditions including hail and cut worms which injured the barley much more than emmer in the tests on alkali soil at Cottonwood.

Use of Barley in Crop Mixtures.

The practice of mixing seed barley and oats or of growing oats following barley so that the resultant crop contains a percentage of volunteer barley and consists of a mixture of barley and oats is common in some localities. In order to test the desirability of this practice or to learn whether greater yields can be produced by growing barley in mixtures with other crops, tests are in progress at Brookings and Highmore. At Brookings, Manchuria barley, Swedish Select oats and White Spring emmer were grown alone and combined using approximately equal parts by weight of seed, that is, three pecks of barley and four of oats, or three pecks of emmer and three of barley. It has been found since these experiments were started that Sixty Day oats are better than Swedish Select oats for this purpose. During the

four years 1914 to 1917, the results have not shown any advantage in growing the crops as mixtures. Barley alone produced an average yield of 2275, oats and barley 1912 and emmer and barley 1712 pounds. In each case, the yield was materially reduced by mixing. In this test oats and barley grown separately yielded an average of 1888 as compared with 1912 pounds for the mixture. Barley and emmer grown separately gave an average yield of 2043 as compared with 1712 pounds for the mixture. Apparently it is not advantageous to mix barley and other crops in eastern South Dakota.

At Highmore, White Smyrna barley and Sixty Day oats were grown singly and combined. The resulting average yields for four years 1914 to 1917 were as follows: barley 2087, oats 2225, barley and oats together 2217, barley and oats grown separately 2156 pounds per acre. After this experiment was started, it was learned that Odessa barley would have been better than White Smyrna for this purpose and Odessa was used during 1917. The results to date do not warrant recommending mixing barley and oats as far as yield per acre is concerned. If for any other reasons, one desires to mix these crops, careful attention should be given to the varieties used. Our observations show that Odessa barley, three pecks and Sixty Day oats, four pecks is the best combination to use.

Varieties to Grow

Five types of barley are of interest to the South Dakota grower. These include the six rowed, bearded, hulled; the two rowed, bearded, hulled; the beardless, hulled, the bearded hull-less and the beardless or hooded hull-less.

The six rowed, bearded, hulled type constitutes the bulk of the barley crop not only of this state, but of the United States. There are two distinct groups within this type, one having nodding heads and the other having heads that are more or less erect. Much of the common barley of the state belongs to the Manchuria var-

iety which is a leading representative of the nodding headed group. The erect type is represented by the Odessa variety which since its introduction has gained steadily in favor. Crop breeders of the Wisconsin, Minnesota, South Dakota and other experiment stations have given considerable attention to selective improvement of the Manchuria variety and have evolved a number of pedigreed strains, which are often better than the original in the regions to which they are adapted.

A number of strains of Manchuria have been tested by the South Dakota station. The best one thus far tested for our conditions is the Manchuria S. D .105 (Minn. No. 105). This strain was introduced from Canada by the Minnesota Experiment Station. In the eastern section it has about matched the Odessa in yield per acre and is somewhat superior to it in resistance to lodging and in uniformity of heighth and type. It is therefore recommended for the eastern quarter and particularly for rich land or low lands. The Odessa on the other hand, has proved superior to all strains of Manchuria in drouth resistance and in yield per acre as an average for all trials in the central and western districts. **While it may be true that there are other varieties better adapted for some special or local condition than Odessa, it seems certain that as a general purpose variety, to be grown throughout the state, Odessa is to be highly recommended.**

Gatami barley is an example of the special purpose variety. It is of the six rowed, bearded type but differs from Manchuria and Odessa in many respects. It is black in color, is extremely early in maturity and has uniformly short heads. It is unfortunately quite subject to shattering and the heads break off rather easily but owing to its extreme earliness, it has given good results in localities where crops are subject to injury by early summer drouth and hot weather. This variety is gaining in favor in some localities in Lyman, Jackson and Fall River counties. It is not recommended for general culture and probably should not be grown east of the

Missouri river at all owing to the danger of getting it mixed with the white barley, but as stated, its extreme earliness makes it desirable as a drouth dodger in some of the western counties.

Hannchen barley is a leading representative of the two rowed type. It has nodding heads and is often nearly beardless at harvest time because a large percentage of the beards fall off at maturity. This variety is especially adapted to the north central counties including Campbell, Walworth, McPherson, etc. It has given good results at Eureka and is also highly recommended by the North Dakota sub-station at Dickinson. It has not gained in favor in the state as a whole and probably should not be grown except in the north central counties, on account of the danger of mixing with the standard six rowed sorts.

Chevalier is another representative of the two rowed type having longer, narrower heads than Hannchen. It has proved the best variety in the trials at Newell on irrigated land being well able to produce a heavy crop, under favorable moisture conditions.

White Smyrna is the earliest maturing two rowed variety tested and is very resistant to drouth. It produces a large grain which is usually of good quality. Under severe drouth conditions the grain matures without emerging from the boot. It is a valuable variety for western South Dakota.

Hull-less barley is so called because the hull is readily removed in threshing. Hull-less barleys have not proved sufficiently productive to warrant their recommendation as grain crops, but they are excellent for temporary hay crops and when combined with rape are good for hog pasture. Nepal is the leading hull-less variety.

Up to date, no beardless variety has been found which is capable of competing with the better bearded kinds, but at least one of the beardless barleys under trial is somewhat promising and can be recommended for trial by those who like to experiment. This variety is known as Horsford. Under favorable season-

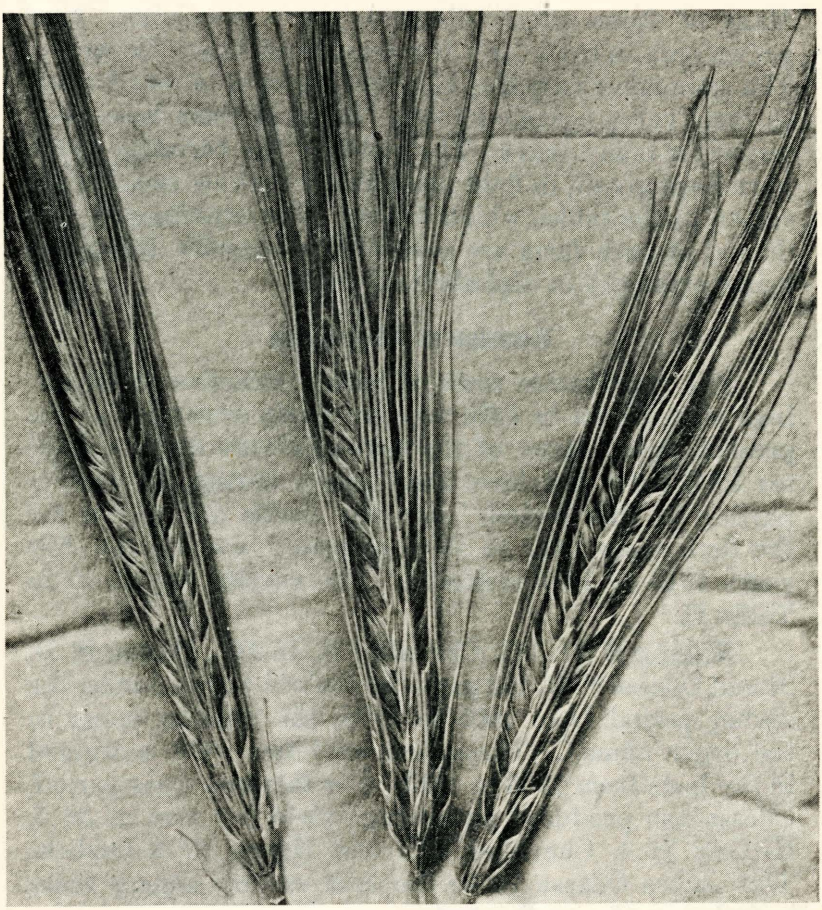

Fig. 5. Odessa S. D. 182 barley is considered the best general purpose variety for the whole state.

al conditions the yields obtained with this variety at Brookings and Highmore have been encouraging. Needless to add, if a productive variety of beardless barley can be found or developed, it will be a much more congenial crop to harvest.

Results of Variety Tests

In order to gain the information above given, it was necessary to conduct a long series of experiments. Hundreds of varieties have been tested at the station farms.

Many of these which did not prove promising, were grown only in rows for a few seasons and then discarded. The promising varieties have been grown in small fields as their value became known. Some of them have been tested for many years. The yields of the varieties which have been grown in field plats at the various stations are shown in the tables which follow. The experiments conducted at each farm are presented separately, the farms being arranged in alphabetical order.

Results at Brookings

The cooperative tests of barley varieties at Brookings were begun in 1902 and are being continued at the present time. Many of the varieties were discarded after 1908 but a few have been grown during the greater portion of this period. Average yields are shown for the four years 1905 to 1908 inclusive and for the five years 1913 to 1917 inclusive. The results are given in Table II.

Kitzing S .D. 189, Chevalier S. D. 107, Hanna S. D. 24 and Odessa S. D. 182 gave the highest yields during the earlier period from 1905 to 1908; the ranking being in the order named. These four varieties were continued in the tests from 1905 to 1913. For this nine year period, Odessa has produced an average yield per acre of 36.5, Kitzing 31.4, Chevalier 29.5 and Hanna 27.8 bushels. This shows Odessa to be the best variety among those included in the earlier tests.

Manchuria S. D. 105 (Minn. No. 105) was added in 1912. During six years, 1912 to 1917 inclusive this variety and Odessa have given the same average yield per acre. In the five year average 1913 to 1917 inclusive, the Manchuria has produced 2.0 bushels per acre more than the Odessa. All of these years, except 1917, were favorable crop years so that the drouth resistance of any variety was not an important factor in determining the yield. In 1917 drouth resistance was important and it is to be noted that Odessa gave a considerably higher yield than the Manchuria. During the past five years no

TABLE II. Annual and average yields in a barley variety test at Brookings 1902 to 1917.

S.D. No.	C. I. No.	Group and Variety	Yield in bushels per Acre. 1902	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	Averages 1905-1908	Averages 1913-1917
		Six-rowed bearded white hulled																	
124	190	Beldi											41.7	25.0	52.0				
	177	Bolton			45.6	35.6	23.3	18.3										30.7	
126	626	Coast											48.9	38.5	64.5				
	184	Common		45.5	44.0	42.5	31.7	24.7										35.7	
	162	Gold Foil			43.5	43.3	21.7	14.5										30.7	
	336	Grecian			38.4	47.3	31.0	28.1										36.2	
	170	Manchuria		48.1	29.1	45.8	33.1	31.8										34.9	
	329	Manchuria				46.2	23.8	27.7											
127	617	Manchuria											51.0						
												(a)							
102	638	Manchuria (Minn. No. 6)		43.3	49.0	41.0	34.6	27.4	24.6	24.2	0	39.3	64.6		64.5			38.0	
102	638	Manchuria (Sel. 7-1910)													62.5				
102	638	Manchuria (Sel. 11-1910)													75.0	50.0	40.1		
												(b)	(c)	(d)	(e)				
105	643	Manchuria (Minn. No. 105)										47.3	64.8	53.2	61.4	43.8	45.8		53.8
105	643	Manchuria (Sel. 27-1912)														46.9	37.8		
123	261	Marioût											30.2						
178	1146	Oderbrucker (Wis. No. 6)											51.0	31.5	71.9	47.9	33.2		47.1
182	182	Odessa		61.2	45.2	50.5	32.1	26.0	26.3	27.7	0.4	57.2	63.5	52.1	52.0	41.3	50.4	38.4	51.8
182	182	Odessa (Sel. 18-1910)													64.5				
182	182	Odessa (Sel. 24 1910)													70.8	39.6	39.0		
	78	Sangatsuko	22.0	27.9	32.9	31.2	21.3	13.3										24.7	
	174	Summit			44.3	42.3	23.3	20.2										32.5	
	171	Surprise			35.2	41.4	16.5	18.9	16.5	11.4	0.3							28.0	
889	920	White Gatami														31.9	33.2		
		Six-rowed bearded, black, hulled																	
122	575	Gatami											47.9	48.9	71.9	36.5	33.2		47.7
		Six-rowed, beardless, white, hulled																	
294	507	Horsford														14.6	32.1		
1135	1177	Horsford (Wing's Pedigreed)															25.5		
		Six-rowed white, bearded, hulless																	
	22	Nepal		29.0	41.3	25.3	12.0	8.8										21.8	
	234	Nepal			42.3	26.2	11.2	5.0										21.2	
262	262	Nepal (Myer's)											25.0	27.9	27.5	13.3	20.0		22.7
	321	Nepal					9.7												

TABLE II. .Continued.

S.D. No.	C. I. No.	Group and Variety	Yield in bushels per Acre															Averages	
			1902	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	916	1917	1908	1917
685		Nepal																	
		Six-rowed blue, bearded, hulless												30.0	24.1				
	335	Little Blue Hull-less																	
		Two-rowed, bearded, white, hulled			36.8	30.9	9.5	5.3										20.6	
	158	Bavarian				40.2	21.0	19.5											
	159	Bavarian		59.9	48.9	36.8	14.6	12.5										28.2	
	160	Bavarian			49.2	36.3	12.9	7.2										26.4	
	208	Bavarian				39.0	17.3	10.1											
27	27	Bohemian	35.6	45.4	42.7	49.5	22.1	18.7					52.0	32.3	30.2			33.2	
	32	Bohemian				44.4													
	204	Bohemian				48.0	16.3	17.5											
	384	Brasseria						16.2											
107	35	Chevalier	31.2	42.9	64.2	50.3	22.5	27.8	15.4	11.0	0.8	32.0	41.7					41.2	
	156	Chevalier				36.8													
408	200	Chevalier		49.4	54.6	49.0	20.0	19.7	17.9	10.8	2.5							35.8	
	530	Chevalier		50.0	60.0	48.8	20.8	22.5	19.4	12.7	2.0							38.0	
460	1145	Gold											48.6	53.1	50.0	22.2	28.6		40.5
	48	Golden Melon	26.0	45.8	46.3	37.0	25.6	16.0										31.2	
24	24	Hanna		47.0	60.6	46.4	19.2	30.1	14.6	19.2	0.0	25.2	35.4	38.5				39.1	
	26	Hanna		42.9	54.8	46.4	21.3	15.2										34.4	
	30	Hanna		45.0	43.5	44.0	20.2	22.0										32.4	
	33	Hanna				36.8													
	34	Hanna				41.7													
	203	Hanna	45.0	47.0	48.3	49.0	23.3	14.7										33.8	
	416	Hanna				54.4	24.0	31.3											
20	531	Hannchen		50.0	57.7	49.4	22.7	15.8	11.5	14.4	1.0	39.1	40.2	36.5	39.2	17.7	24.1	36.4	31.5
	209	Highland Chief				42.3													
	31	Horn				41.4													
	167	Kitzing				43.5	19.2	13.6											
189	189	Kitzing			54.7	53.8	22.9	39.3	15.2	24.8	0.2	50.0	21.9					42.7	
	201	Kitzing		44.2	46.3	44.6	21.0	13.5										31.3	
	207	Lower Frankish		57.0	47.5	50.4	10.6	20.0										32.1	
	343	Moravian		9.7	50.1	54.3	24.4	23.9	18.7	10.6	0.8							38.2	
	172	Newton				35.4													
	532	Primus		42.1	45.8	37.3	14.2	19.5										29.2	
	193	Princess				37.5													
	529	Princess		50.4	50.8	41.1	12.3	15.8										30.0	
	169	Prize Prolific			39.8	41.7	14.0	14.1										27.4	
	46	Senbaks						16.2											
	47	Striegum	23.3	42.5	30.0	43.1	20.8	13.9										26.9	
439	187	Swan Neck		69.0	45.0	49.1	23.8	24.5	17.5	12.5	0.4	40.8	32.9					35.6	
28	195	White Smyrna											45.4	45.6	33.3	31.6	33.2		37.8
		Two-rowed, white, bearded, hulless																	
442	314	Poppenheim														11.7	16.6		

(a) average of 3 plats not in varietal test.
(b) average of 4 check plats.
(c) average of 6 check plats.
(d) average of 4 check plats.
(e) average of 3 plats.

other variety has approached the Manchuria and Odessa in yield. Oderbrucker, Wis. No. 6 another strain of the Manchuria variety, which is the one commonly grown in the state, gave a yield of 47.1 bushels or 6.7 bushels per acre less than the Manchuria S. D. 105.

Fig. 6. Manchuria S. D. 105 is adapted to rich land in the eastern sections.

The growers in the eastern part of South Dakota will do well to use either the Manchuria S. D. 105 or Odessa S. D. 182. The grain from these varieties is identical so that there will be no injury when the two are mixed at the market.

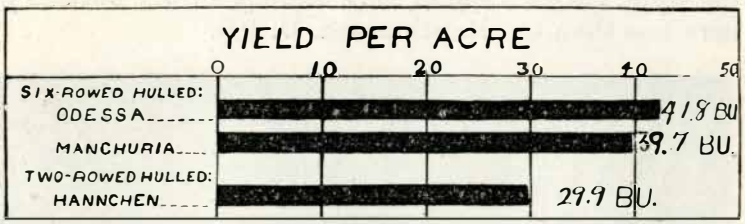

Fig. 7. Diagram showing the average yield in bushels per acre of Odessa, Manchuria S. D. 102 and S. D. 105 and Hannchen barley at the Brookings station, for 14 years, 1904 to 1917 inclusive. In 1914, 1916 and 1917 Manchuria S. D. was not grown. The yields of Manchuria S. D. 105 for these three years were used in determining the average yield.

A few of the growers trying the Odessa report it to be more subject to lodging than the Manchuria. Inquiry has shown that in most cases where severe lodging occurred the Odessa was grown on very rich soil with abundant moisture. It is very probable that under exceptionally favorable conditions such as these the Manchuria is the better variety to grow. On the other hand where conditions are adverse due to lack of moisture or when the soil is only of average fertility, Odessa is likely to give the better returns.

The hull-less varieties do not compare favorably with the better hulled varieties in yield of grain. None of the two rowed varieties are adapted to eastern South Dakota conditions.

Cottonwood Results

Variety tests of barley were begun at Cottonwood in 1909, the first crop being sown on newly broken sod. In 1910, 1911, 1913, 1914 and 1917 severe drouths reduced crop yields. In 1912 the barley varieties were destroyed by cut worms and in 1915 by hail so that during three seasons when moisture was plentiful some other factor intervened to destroy the crop. Of the nine years included in the test 1916 was the only season when cropping conditions for barley were reasonably favorable. In spite of unfavorable conditions, it has been possible to learn a number of things about barley varieties. The tests clearly indicate that Manchuria barley is of little or no value for this section. Some variety that has ability to dodge or resist drouth is required. The Hannchen during nine years yielded an average of 8.3 bushels per acre as compared with 3.3 for Manchuria. Drouth resistant varieties from the trials at Highmore have been introduced from time to time. Among these, Odessa S. D. 182 has yielded an average of 18.7 bushels as compared with 15 for Smyrna, 14.3 for Hannchen, 12.7 for Gatami and 10.1 for Manchuria during the two years 1916 and 1917. It is evident that in the present state of our knowledge Odessa is the variety to be recommended for general culture in this area. Hannchen has nearly always failed to produce a crop of good quality. Smyrna has very short straw and is not desirable for that reason, unless it is capable of yielding a greater quantity or better quality of grain than Odessa. Gatami is exceptionally early and for that reason has a better opportunity to dodge drouth than Odessa. It is not recommended as a general crop, but may be of value in some localities owing to its earliness. It is not equal to Odessa in producing power under reasonably favorable seasonal conditions. Results of all barley variety tests are presented in Table III.

Fig. 8. Gatami S. D. 122 is a very early black variety.

Fig. 9. Nepal S. D. 262 is suitable for hog pasture or hay, but does not make a satisfactory yield of grain.

TABLE III. Anual and average yields in variety test of barley at Cottonwood, 1909 to 1917.

Number S. D.	Number C. I.	Group and Variety	1909	1910	1911	1912	1913	1914	1915	1916	1917	Averages 1909-1917	1916-1917
102	638	Six-rowed bearded white, hulled Manchuria (Minn. No. 6)..	1.0	2.0				(a)		(c)	(c)		
105	643	Manchuria (Minn. No. 105).....	2.0	3.1		2.6	0.4	1.3	hail	19.9	0.3	3.3	10.1
178	1146	Oderbrucker (Wis. No. 6).....	2.2	3.1									
182	182	Odessa						(b)		25.8	11.6		18.7
		Six-rowed bearded, black, hulled						6.6	hail	19.9	5.4		12.7
		Two-rowed bearded white, hulled											
	32	Bohemian	3.9	1.6									
		Chevalier	3.4	2.9									
	48	Golden Melon		1.2									
	34	Hanna	2.8										
24	24	Hanna	2.4	3.5									
	203	Hanna	1.6					(c)					
20	531	Hannchen	6.1	3.5				3.1	8.6	18.5	10.0	8.3	14.3
	31	Horn	4.9	2.2									
28	195	Smyrna								19.4	10.5		15.0

(a) average of 2 plats.
(b) average of 3 plats.
(c) grown on corn ground.

Results at Eureka

Barley experiments were begun at Eureka in 1909 with a preliminary trial of 16 varieties. After three years, it became necessary to reduce the amount of land occupied by barley variety tests to make room for other experiments. In doing this it was necessary to discontinue a number of varieties. Those that were retained included Manchuria S. D. 105, representative of the six row type and Hannchen S. D. 20 the leading representative of the two row type. Gatami S. D. 122 was added because it had shown extreme earliness in trials at Highmore and Smyrna was continued one year because of its good record at Highmore. It is unfortunate that it was necessary to discontinue Odessa in 1912 due to lack of room, but to retain Odessa would have meant to discard one of the other type representatives that were needed, so that it was decided to leave out Odessa at Eureka and depend upon results obtained at Highmore to supplement the tests conducted from 1909 to 1911 with this variety. The outstanding facts brought out by these tests are as follows:

1. Odessa ranked first during the three years tested among 16 varieties, and is without question the best six row variety for this section.

2. Manchuria is clearly not adapted to this district owing to its lack of drouth resistance.

3. Hannchen is the leading variety among those tested during 1912 to 1917 having yielded an average of 6.5 bushels more than Manchuria S. D. 105 the leading pedigreed strain of the variety commonly grown. The only objection to the culture of Hannchen barley throughout this section of the state is that it is a two-rowe dsort and care must be constantly exercised to avoid mixing with the common six rowed barley. The barley grower in this district will be safe in choosing either Odessa or Hannchen.

TABLE IV. Annual and average yields of barley varieties at Eureka, 1909 to 1917.

S. D.	C. I.	Variety	1909	1910	1911	1912	1913	1914	1915	1916	1917	Averages 9 yrs. 1909-1917	Averages 6 yrs. 1912-1917
		Six-row, bearded	(b)										
102	638	Manchuria (Minn. No. 6)	30.9	5.1									
						(a)	(a)	(b)	(b)	(b)	(b)		
105	643	Manchuria (Minn. No. 105)	31.2	6.0		2.6	6.4	22.8	60.1	43.2	27.0	22.1	27.0
178	1146	Oderbrucker (Wis. No. 6)	33.3	2.7									
			(a)										
182	182	Odessa	29.5	5.2									
							(b)	(b)	(b)	(b)	(b)		
122	575	Gatami				23.4	11.4	30.9	39.2	16.8	19.6		
		Two-row bearded		7.3									
27	27	Bohemian	32.1	8.0									
				(b)									
21	530	Chevalier	31.0	0.3									
	48	Golden Melon	26.2	1.3									
24	24	Hanna	18.7	4.3									
				(b)									
	34	Hanna	23.1	3.3									
			(b)										
	203	Hanna	18.7	3.1									
				(b)		(b)	(b)	(a)	(a)	(a)	(a)		
20	531	Hannchen	29.6	3.8		21.4	16.5	30.5	67.5	33.0	32.2	26.0	33.5
	31	Horn	27.5	12.2									
	532	Princess	18.7	1.7									
	529	Princess	28.3	0									
	47	Striegum	27.1	3.9									
28	195	White Smyrna		7.2		7.8							

(a) average 3 plats.
(b) average 2 plats.

Results at Highmore

The varietal tests with barley were begun at Highmore in 1903, but only one variety, White Smyrna S. D. 28 has been grown every year during this period. The rule has been to continue a variety in the tests until it has proven inferior to the leading varieties. Until 1909 all varieties were grown in tenth-acre plats. Beginning with that year a system of promotion or demotion was used. Only the leading varieties were grown in field plats, while new varieties and strains were first started in rows and then promoted or discarded according to their performance. A number of varieties have been tested that have never shown any value for South Dakota conditions and their record does not appear in Table V. Those varieties only that have been grown in field plats are reported. The data is complete in this respect as it includes all varieties grown in field plats from 1903 to 1917 inclusive. No averages are given in this table.

It is possible to compare the performance of any certain varieties by adding up the yields for each variety and dividing by the number of years both were included in the test. The leading varieties are compared for the 11 year period, 1907 to 1917 inclusive, in Table VI. The 11 year average shows Odessa to have produced 2.8 bushels per acre more than either Hannchen or White Smyrna, its closest rivals. In the 8 year average, 1910 to 1917 inclusive, Odessa has produced 1.5 bushels per acre more than Coast which ranks second. Coast barley has heavy, rough, and persistent beards which make it very disagreeable to handle and hard to thresh and for that reason, it has not been increased for distribution in this state. Gatami ranks third having produced 1.2 bushels more per acre, as an average for 8 years, than White Smyrna which ranks fourth.

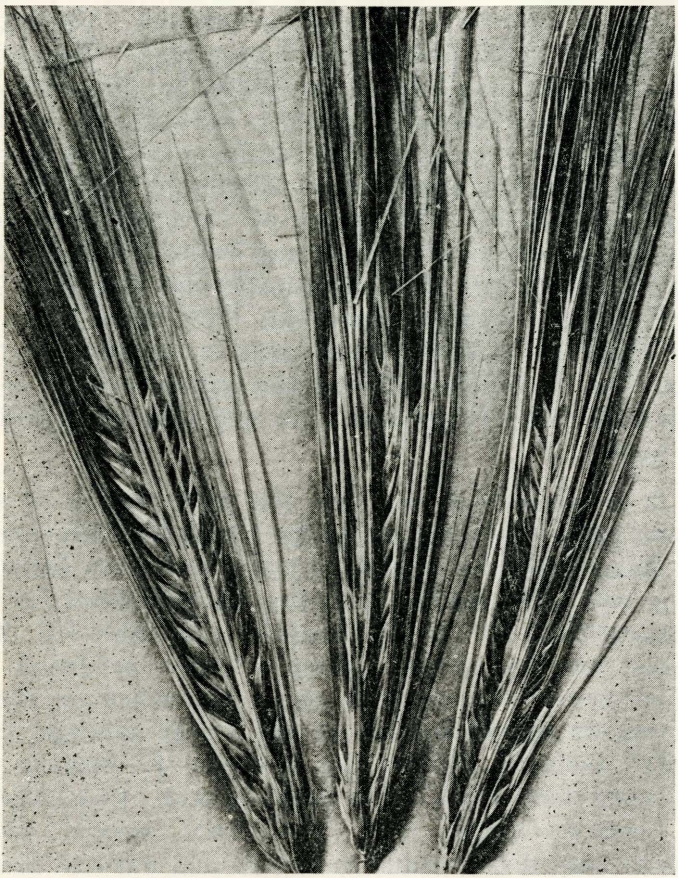

Fig. 10. Coast S. D. 126, an example of the harsh bearded type of six rowed barley.

TABLE V. Annual and average yields in a varietal test of all barleys grown in field plats at the Highmore station, 1903 to 1917.

S. D. No.	C. I. No.	Variety	Yield in bushels per acre													
			1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917
		Six-rowed, bearded															
124	190	Beldi								12.3	0.0	6.9	4.8	26.2			
126	626	Coast								8.3	0.0	3.9	7.3	44.8	79.0	45.1	30.7
127	617	Manchuria								14.0	0.0	0.9					
102	638	Manchuria (Minn. 6)	27.5	16.8	37.7	43.3	22.7	24.4	14.6	8.1	0.1						
105	643	Manchuria (Minn. 105)					22.7	27.7	15.8	14.6	0.0	0.2	0.8	30.0	68.6	38.9	29.7
123	261	Mariout								15.6	0.0	5.5	4.8	36.4	49.9		
178	1146	Oderbrucker (Wis. 6)						28.3	15.6	10.8	0.0	0.5					
182	182	Odessa					23.8	32.3	15.8	7.5	0.0	2.1	6.9	47.9	79.0	54.2	33.8
182	182	Odessa (Sel. 24-1910)														39.2	
232	182	Odessa														43.7	
139	691	Pullman												39.8	39.8	64.5	
	25	Saale			42.7.												
122	575	Gatami								8.0	0.0	8.6	5.0	48.9	65.9	42.3	34.1
889	920	White Gatami														43.1	34.3
		Six-row, beardless															
19	102	Arlington Awnless.												32.3	43.7		
294	507	Six-row, hooded Horsford														31.9	22.6
1135	1177	Horsford (Wings Ped.)															24.7
		Two-rowed, bearded															
	29	Bestehorn Imperial	12.3	10.0													
		perial	12.3	10.0								not					
27	27	Bohemian	16.5	12.3	46.8	31.3	27.7	38.4	20.8	19.2	0.0	grown	1.3	74.9	33.8		
	32	Bohemian	18.3	10.4	54.1	32.7	21.7	30.0	17.3	11.5							
	72	Cape	0.0	0.0													
	23	Chevalier	12.1	11.0													
	35	Chevalier	16.5	14.7	45.6												
	530	Chevalier			48.5	50.6	25.2	22.9	14.8	15.4	0.0	0.2					
87	714	Caucasian														43.7	

TABLE V. Continued.

S. D. No.	C. I. No.	Variety	Yield in bushels per acre 1903	1904	1905	1916 | 1917 1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	
	62	Doitsu Harumaki..	12.1	20.8	36.6										39.9	
143	679	Franconian														
460	1145	Gold										0.8	34.3	72.8	35.4	22.4
	48	Golden Melon	10.6	10.4	51.0	28.5	20.8	26.4	11.5							
24	24	Hanna	19.4	17.5	50.6	36.8	22.9	34.6	15.6	13.3	0.0	0.4	2.1	39.0	64.5	
	26	Hanna	15.8	16.5	45.0											
	28	Hanna	15.6	10.8	46.0											
	30	Hanna	13.1	23.5												
	33	Hanna	12.3	15.4												
	34	Hanna	15.6	11.0	51.6	32.5	21.5	35.2	18.8	16.7	0.0	0.2				
	203	Hanna	14.4	15.2	53.5	30.4	21.5	35.2	19.6	14.0						
20	531	Hannchen			41.8	56.8	26.0	29.0	15.8	14.6	0.0	0.2	3.1	56.1	64.6	40.0	23.4
	31	Horn	14.4	12.7	54.4	25.4	21.5	28.1	15.4							
	529	Princess			40.8	47.9	22.7	18.8	11.0	10.8	0.0	0.2				
	603	Princess								9.4	0.0	0.2				
	532	Primus			40.0	36.4	27.3	22.0	9.8							
	39	Rokaki-Chevalier .	15.8													
	52	Santoku	0.0													
	54	Shiro Nishki	0.0													
	47	Striegum	15.6	13.1	47.9	25.4	18.6	32.1	14.2							
	50	Tanikaze	0.0													
28	195	White Smyrna ...	16.6	16.6	45.4	30.4	19.6	29.8	19.6	14.0	0.0	8.6	10.8	37.9	60.3	41.6	30.2
	191	Black Smyrna	24.5	22.3	40.8											
		Two-row bearded, hulless														
442	314	Poppenheim													18.3	13.7
		Miscellaneous														
	1147	Harlans Composite										0.3	3.1	29.1	60.3	42.4

TABLE VI. Annual and average yields of the leading varieties of barley at Highmore, 1907 to 1917.

Number S. D.	Number C. I.	Variety	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	Averages 1907-1917	Averages 1910-1917
Six-row															
126	626	Coast				8.3	0.0	3.9	7.3	44.8	79.0	45.1	30.7		27.4
105	643	Manchuria (Minn. No. 105)	22.7	27.7	15.8	14.6	0.0	0.2	0.8	30.0	68.6	38.9	29.7	22.6	22.8
182	182	Odessa	23.8	32.3	15.8	7.5	0.0	2.1	6.9	47.9	79.0	54.2	33.8	27.6	28.9
122	575	Gatami				8.0	0.0	8.6	5.0	48.9	65.9	42.3	34.1		26.6
Two-row															
20	531	Hannchen	26.0	29.0	15.8	14.6	0.0	0.2	3.1	56.1	64.6	40.0	23.4	24.8	25.2
28	195	White Smyrna	19.6	29.8	19.6	14.0	0.0	8.6	10.8	37.9	60.3	41.6	30.2	24.8	24.4

TABLE VII. Comparison of Smyrna and Odessa for weight per bushel at Highmore, 1909-1917.

Variety	Number S. D.	Number C. I.		1910	1911	1912	1913	1914	1915	1916	1917	Averages 1909-1917
White Smyrna	28	195	48.5	50	0	34	36	44	43	40	46	43
Odessa	182	182	44.0	43	0	29	34	45	47	33	42	40

TABLE VIII. Annual and average yields of barley grown on dry land, on the Belle Fourche Experiment Farm, 1908 to 1916 inclusive.

Group and Variety	S. D. No.	C. I. No.	Yield in bushels per acre 1908	1909	1910	1911	1912	1913	1914	1915	1916	Averages 1909-1916	1912-1916
Six-rowed white, hulled													
Manchuria (Minn. No. 105)		354					7.6	6.6					
Manchuria (Minn. No. 105)	105	643	26.0	17.3	4.3	0	7.2						
Manchuria (Minn. No. 6)	102	638		19.8	5.2	0	8.1	8.0	4.2	62.1	20.2	15.9	20.5
Odessa	182	182		22.1	8.1	0	9.8	8.7	3.5	69.4	26.1	18.4	23.5
Coast		690								82.8	18.3		
Six-rowed, black, hulled													
Gatami	122	575					18.3	8.2	6.9	50.6	28.2		22.4
Six-rowed naked													
Himalaya (Guy Mayle)	296	620								58.4	18.3		
Nepal (Myer Hull-less)	262	262	16.3	9.6	2.5	0							
Nepal (White Hull-less)		595	12.0	9.0	1.7	0	10.7	8.9	4.9	50.8	13.1	12.3	17.6
Two-rowed hulled													
Chevalier II		530		22.1 (a)	0 (a)	0	0	6.8	1.1				
Hanna	24	24	29.0	23.8	1.0	0	0	10.7	2.7				
Hanna		203	27.9	**21.4**	1.4	0	0						
Hannchen	20	531		**19.2**	3.1	0	0	12.7	6.7	85.9	23.5	18.8	25.7
White Smyrna (Ouchac)	517	658					10.7	14.3	14.4	76.2	24.6		28.0
White Smyrna	28	195								77.9			

(a) Average of 2 plats.

All the barley varieties have nearly the same weight per bushel each season, except the White Smyrna which owing to its large plump grain nearly always gives a test weight of from 1 to 7 pounds per bushel heavier than other varieties. A comparison between the test weight per bushel of Odessa and White Smyrna for the 9 year period 1909 to 1917, inclusive, is presented in Table VII. The 9 year average shows the White Smyrna barley to have tested 43 pounds, or 3 pounds per bushel, more than Odessa variety. If we assume that this would give the White Smyrna an advantage over the Odessa of 10 cents per bushel the two varieties would be approximately equal in cash value in spite of the higher average yield of Odessa. The barley grower in this district will probably prefer the Odessa, all evidence considered.

Results at Newell on Dry Land

The varietal tests of barley on the Belle Fourche Experiment farm at Newell, were begun on the dry land in 1908. Only one variety has been grown continuously since then, but four varieties have been grown since 1909. Average yields are given for the past eight years and for the past five years. The yields are shown in Table VIII.

The Hannchen variety shows the highest average yield from 1909 to 1916, it being slightly above Odessa. The White Smyrna and Gatami varieties were added to the test in 1912 and since that time the White Smyrna has yielded more than the Hannchen. It is evident that White Smyrna is the best variety for growing without irrigation in this area, quality and yield considered.

Results at Newell on Irrigated Land

Since 1912 a test of barley varieties under irrigation has been conducted at Newell. The yields in these tests have not been as high as might be expected on irrigated land but the plats have usually been on poor soil, the seeding was too late, or the seasonal conditions unfavorable. Much better yields have been secured from barley on other fields on the experiment farm. The yields are shown in Table IX.

Fig. 11. Hannchen S. D. 20, a leading variety of the two rowed type.

The Chevalier varieties have given the highest average yields during the past three years. Hannchen yields well in some years. The Chevalier barley is similar to the Hannchen except that the heads appear more slender. The kernels are plump and lie closer to the rachis or central stem within the head, than the Hannchen. Chevalier barley is of excellent quality when grown under favorable conditions. It matures a few days later than the Hannchen and fully a week later than

TABLE IX. Annual and average yields of the barley varieties grown under irrigation on the Belle Fourche Experiment Farm, 1912 to 1916 inclusive.

Group and Variety	Number S. D.	Number C. I.	Yield in Bushels per Acre 1912	1913	1914	1915	1916	Average 1914-1916
Six-rowed hulled								
Manchuria (Wis. No. 13)		905		25.8	21.8	20.9	14.7	19.1
Manchuria (Minn. No. 6)	102	638	16.9					
Manchuria (Minn. No. 105)		354		23.5	17.8			
Odessa	182	182	17.4					
Coast		690				23.0	15.2	
Two-rowed hulled								
Chevalier		1142			26.8	37.2	23.2	29.0
Chevalier II		530	13.0		23.0	39.2	23.9	28.7
Hannchen	20	531	19.8	32.9	15.0		25.1	
Six-rowed naked								
Himalaya (Guy Mayle)	296	620			26.6	23.4	17.5	22.5
Nepal (White Hull-less)		595	9.1		19.2	20.4	14.9	18.1

Manchuria. Under the conditions existing at Newell the early six-rowed varieties become ripe before they are greatly benefited by irrigation, while the later maturing two-rowed barleys such as Chevalier have an opportunity for full development.

General Conclusions Regarding Barley Varieties

Odessa has given the best average results of all varieties tested and is evidently the best general purpose barley for the state as a whole. Manchuria S. D. 105 is adapted to rich lands in the eastern section. White Smyrna is early maturing and drouth resistant and is adapted to production without irrigation in the western section. Hannchen appears to be best suited to conditions in the north central section. Whether it is superior to Odessa for that area is not known, but such data as is available indicates that the two varieties are approximately equal in producing power in that area. Though large amounts of Hannchen seed have been distributed, it has not become popular among South Dakota growers. Chevalier is adapted to production on irrigated land in the western section according to results at Newell, but is not commonly grown as yet in that district. Gatami is extremely early and has excelled in some of the drier seasons because it was able to come nearer maturing its grain before drouth set in, than varieties requiring a longer season. As an average it has not been as productive as Odessa.

Seed Improvement

It is economy to use the best seed obtainable. Poor seed is a common cause of thin stands, weak germination and weedy fields. Seed barley should be bright and plump. Most of the shriveled, poorly developed grains can be blown out with the fanning mill. If the barley has been injured by heating in the stack or bin, it must not be used for seed unless a germination test has shown it to be viable.

The score card given here is used by the South Dakota State College in the farm crops classes. This will serve as a guide in the selection of good seed barley.

SOUTH DAKOTA STATE COLLEGE AND EXPERIMENT STATION

AGRONOMY DEPARTMENT

Students' Score Card—Barley Grain

Motto—Better Barley

Variety Characteristics

Type of Head .....

Color of Grain .....

Awn Persistent or Deciduous .....

Awned or Hooded .....

Market Class .....

Examination of Sample	Perfect test	Number of Sample			
Germination	100				
Pure Seed	100				
Inert Matter	0				
Weed Seed	0				
Scoring Sample	**Perfect Score**				
Size	10				
Uniformity Shape	10				
Color	20				
Market Condition	25				
Purity	25				
Pedigree or History	10				
..Total Score	100				
Market Grade	1				

LEADING VARIETIES FOR SOUTH DAKOTA BY CLASSES

Barley (Six Row)

Manchuria, S. D. 105
Odessa, S. D. 182

Chevalier (Two Row)

Hanchen, S. D. 20
White Smyrna, S. D. 28

Special (Black Six Row)

Gatami, S. D. 122

Explanation of Points

Variety Characteristics—Barley varieties vary in color of grain, type of head and persistence of awns.

Germination and vitality refer to the ability of seed to grow. A reasonably good test is 95 per cent.

Purity means freedom from inert matter and weed seed. Cockle, wild oats, wild morning-glory and quack grass are especially to be avoided and samples containing any of them should be disqualified for seed purposes.

Uniformity in size, shape and color indicates that the seed has been stacked or threshed without being exposed to rain and has been thoroughly cleaned.

Uniform bright color indicates that the seed has been harvested and threshed under favorable weather conditions and may indicate vigor and vitality.

Pedigree or history refers to the locality where grown, and the original source of the variety. It is important to plant seed that grew on plants that have withstood severe conditions as this indicates hardiness. Therefore, the pedigree should be known.

Market condition includes soundness, freedom from cracked, shriveled and sprouted grain, smut, scab and mustiness.

The barley used for seed should be free from all foreign material. The fanning mill will remove most of this. The seed of a good variety should not be allowed to become mixed with other varieties. Pure varieties can frequently be sold at a premium as seed grain, but it is desirable at all times to have pure seed so that the time of ripening and the quality of grain will be uniform. There will be very little mixture if the bags, bins, drill and threshing machinery are cleaned out before receiving the seed grain each time. Barley which contains any appreciable amounts of weed seeds should not be sown until carefully cleaned.

Experiments With the Specific Gravity or Float Method of Grading Seed Barley.

Experiments to test seed barley with all the light kernels removed as compared with the ordinary seed of the same variety thoroughly cleaned over a fanning mill were started at Brookings in 1913, and continued until 1915 and at Highmore in 1912 and continued until 1916. The method was as follows: A sample of barley seed cleaned thoroughly with a fanning mill was poured into a vessel containing water at a temperature of 60 degrees F. All that floated was removed, only the kernels that sank being retained for planting. In comparison with this sample, another lot of the same seed barley was planted without being submitted to the floating and skimming. The annual and average yields at Brookings are presented in Table X. The yields given are the average of duplicate plats. The Manchuria S. D. 105 variety was used in the tests. The annual yields show the treated seed to have given a marked increase in 1913. In 1914 the treated seed gave a slight increase, and in 1915 treated seed gave a marked decrease. The 3-year average shows an increase of 2.2 bushels per acre for the treated seed.

TABLE X. Annual and average yields obtained in a comparison of barley seed graded by the specific gravity method and untreated seed, using Manchuria S. D. 105 barley at Brookings, 1913 to 1915.

Method Treatment	Yield in bushels per acre			
	1913	1914	1915	3 yrs. Average
Treated	70.8	57.8	61.4	63.3
Not treated	61.4	56.3	65.6	61.1

Fig. 12. White Smyrna S. D. 28 is a very early white two rowed variety noted for drouth resistance.

The annual and average yields obtained from the Highmore experiments are presented in Table XI. The yields given are averages of two plats. In 1912 the Manchuria S. D. 105 and Hannchen varieties were used. After that the Odessa was substituted for the Manchuria. In all years except 1915 the yields are in favor of the seed not treated. The five year average shows a slight increase for the seed which was not treated. The results indicate that very little increase if any can be obtained in the yield of barley by treating well cleaned seed by

the specific gravity method such as was used in these experiments. The amount floated off was never over 10 per cent and usually not over 5 per cent of the seed by weight. With a good fanning mill, it is possible to clean and grade the seed in good shape, without resorting to the float method but where the light seeds missed by the fanning mill can be floated off without any additional labor or expense while treating to prevent smut, the seed may be slightly improved.

Environmental Experiments.

The environmental experiment with barley was begun at Highmore in 1910 and continued to include 1916. The annual and average yields are presented in Table XII. The object of the environmental experiment was to determine whether barley from some other source would produce more than continuously home grown seed and also to learn the effect of changing environment upon its chemical composition.

TABLE XI. Annual and average yields obtained in a comparison of barley seed graded by the specific gravity method and ungraded seed on the Highmore station 1912-1916.

Method of Treatment	1912	1913	1914	1915	1916	Average 1912-1916
Treated	0.2	3.5	44.8	80.1	44.2	**34.5**
Not treated	0.3	3.7	52.0	71.8	48.9	**35.3**

TABLE XII. Annual and average yields obtained in an environmental experiment with Hanna barley S. D. No. 24 at Highmore 1910 to 1916.

Source of Seed	1910	1911	Yield in bushels per acre 1912	1913	1914	1915	1916	Average 1910 to 1916
Highmore, S. D.	6.9	Failed	0.2	3.1 (a)	26.5	41.8 (a)	31.3	**15.7**
Bozeman Mont.	11.7	Failed	0.1	3.4	31.2	45.3	27.9	**17.1**
Edgeley, N. D.	10.0	Failed	No Seed	1.7	22.9	41.2	26.7	**14.7**

(a) In 1913 the barley received from Montana was a six-rowed type probably Odessa instead of Hanna and in 1915 there was a large percentage of this type of barley mixed with the Hanna which doubless affected the yield and interfered with the accuracy of the results.

Hanna barley seed that had been grown at the Highmore farms for a number of years was sent the experiment farms at Bozeman, Mont. and Edgeley, N. D. in 1910. Similarly seed of the same variety grown at Bozeman, Mont. and Edgeley, N. D. was sent to Highmore. Thus, three plats of Hanna barley were planted, one from Highmore seed, one from Edgeley seed and one from Bozeman seed. Each year, during the period covered by the ex-

periment, each station furnished seed from its continuously home grown seed plat to each of the other stations. Seed from the crop of the previous year was used whenever possible. In a few instances where the crop was ruined at one of the stations seed was furnished from the preceding year's crop and in one instance the Edgeley plot had to be omitted due to lack of seed. Analyses of the resultant crop from each plat were made each year from 1910 to 1915 by the Bureau of Chemistry, U. S. Dept. of Agriculture. Results of these analyses are given in Table XIII.

TABLE VIII. Results of Barley Analyses in an environmental experiment with the variety Hanna S. D. 24 (C. I. No. 24) at Highmore, 1910 to 1915.

P. C. No.	Source	Water %	Ash %	Nitrogen %	Protein Nx6.25 %	Fat %	Fiber %	Pentosans %	Sugars %	Weight per 1,000 grams	Hulls %	Weight per bu.
					Crop of 1910							
7421	S. Dak.	7.82	3.11		19.70	2.04	4.43	9.34	2.77	27.1	10.4	
7423	Mont.	8.06	3.12		16.10	2.11	4.19	9.06	2.82	32.5	9.3	
7422	N. Dak.	7.65	2.93		18.50	2.25	4.19	9.23	2.70	26.5	10.3	
					Crop of 1912							
12122	S. Dak.	8.98	3.35	3.06	19.12	1.97	4.89	9.49	3.07	28.0	9.4	
12123	Mont.	8.40	3.31	3.12	19.50	2.11	4.47	9.29	3.08	31.5	10.8	
	N. Dak.				Not received for planting							
					Crop of 1913							
12998	S. Dak.	8.40	3.24	3.22	20.12	2.10	4.36	8.56	2.88	34.2	11.5	
12999	Mont.	8.44	2.89	2.93	18.31	1.95	4.88	8.82	2.53	27.6	10.3	
13000	N. Dak.	8.63	3.38	3.25	20.31	2.24	4.22	7.83	2.99	33.4	11.6	
					Crop of 1914							
15389	S. Dak.	7.24	2.89	2.62	16.38	1.62	4.46		3.07	34.2		49.0
15390	Mont.	7.44	2.82	2.73	17.06	1.73	4.60		3.23	32.0		49.4
15391	N. Dak.	7.05	2.96	2.78	17.38	1.81	4.63		3.34	31.2		48.1
					Crop of 1915							
17042	S. Dak.	8.21	2.86	2.45	15.31	1.65	5.60		3.29	29.2		45.2
17043	Mont.	8.90	2.61	2.25	14.06	1.59	5.36		2.90	29.6		45.6
17044	N. Dak.	8.20	2.97	2.50	15.63	1.66	4.82		3.20	28.9		45.6

It is apparent from the results quoted, that no marked difference either in yield or chemical composition can be obtained by transferring seed barley of the same variety from Montana or North Dakota to South Dakota. The yields varied in single seasons, due to difference in quality or purity of the seed, but the difference in the average yields was negligible. Some variations occured in the chemical composition each season, but the variation was not constant and in any case insufficient to be of practical importance.

Changing seed or replacing home grown seed is only

necessary when one wishes to replace an undesirable variety with one better adapted to his conditions or to replace seed of poor quality due to shriveling, mixing or disease.

Seed Treatment, Diseases and Their Prevention.

There are several diseases of barley that are prevalent enough to be worthy of attention. All of them are of fungous or bacterial origin. It is our purpose here to discuss the affects of these diseases upon the barley and to suggest methods that will aid in preventing their serious development rather than to describe the diseases themselves.

Rust (Puccinia graminis) may be recognized by streaks or spots of rusty looking fungus on the leaves or stems of the plant. These spots turn dark, almost black as the season advances, due to the formation of black spores, a later stage of the disease. Since the rust is disseminated in the air during the growing season, the barley seed has little if anything to do with propagating the disease and therefore no method of treating or selecting the seed is effective in preventing it. Fortunately the rust disease requires considerable time to develop and for that reason it is often possible to evade it by seeding early and by the use of early maturing varieties such as have been recommended on a previous page.

Stripe Disease (Helminthosporium graminum) may be recognized by the long, narrow, discolored or blighted stripes, which it forms on the leaves as well as by the shriveled, half formed or blighted heads. The kernels of affected heads fail to fill, are very slender and of an unhealthy looking yellowish color. This is a seed borne disease and is quite successfully combated by thoroughly grading the seed to eliminate the diseased kernels and disinfecting by soaking two hours in a formalin solution consisting of one pint of formalin to 35 gallons of water and then spreading the seed out to dry. This method of treatment has been developed recently by A.

G. Johnson cereal pathologist at the University of Wisconsin and collaborator with the Office of Cereal Investigations, U. S. Department of Agriculture. It is reported to have given very successful results both in laboratory experiments and field trials.

Net Blotch (Helminthosporium teres) and **Spot Blotch** (Helminthosporium sativum) are closely related diseases often known under the common designation, barley blight. They may be recognized by the blighted spots or blotches that are to be found on the barley leaves.

Ergot (Claviceps purpurea) is common to all cereals and many wild and tame grasses. It usually does not develop seriously in barley. This disease destroys individual kernels and replaces them with masses of a grayish fungous growth which often takes the same shape as the grain which it replaces but is larger in size. These ergot masses fall on the ground or are threshed with the grain. Those which fall on the ground germinate the following spring and infect the next crop if one is planted which is subject to ergot. Those which are threshed with the grain will germinate and infect the crop if not removed from the seed barley before planting. Fortunately, the ergot masses are short lived so that if kept with dry seed grain until the second spring, most of them will be dead. The remedy then consists in using ergot free seed or seed that has been kept over a year and rotating the crops to avoid sowing on infected soil. Corn, potatoes, peas, beans, clover, etc. are suitable crops to use for rotation purposes.

Covered Smut (Ustilago hordei) destroys the entire barley head, replacing the grain with masses of jet black spores. The masses are enveloped in a tissue like membrane. This is a seed borne disease and may be prevented by disinfecting the seed by dipping in or spraying with a solution consisting of **one pint of formalin** to 40 gallons of water. The seed may be placed in gunny sacks and dipped for a few minutes or it may be sprayed and shoveled over until each grain has been moistened. If the latter method is used, it is a good plan to cover the

pile of seed with canvas or blankets for about half an hour. This will retain the formaldehyde fumes and thus make the disinfection more thorough. After the seed is treated it should be spread out to dry unless it is possible to seed it at once. This is exactly the same treatment as that used for covered smut of wheat and smut of oats, although they are distinct diseases and do not transfer from one crop to the other.

Loose Smut (Ustilago nuda) destroys the entire head, replacing the grain with black spores. These spores are blown about by the wind leaving very little of the diseased head remaining except the rachis or central axis of the head. This is also a seed borne disease and may be prevented by a rigid disinfection of the seed grain, by what is known as the modified hot water treatment. The ordinary formalin treatment is not effective because of the fact that the germ or carrier of the loose smut disease is within the barley grain, infection having taken place during the development of the grain the year before. Thus it requires a much more severe treatment to kill the smut that is the case with covered smut. The hot water treatment is effective as a prevention for both loose and covered smut. On account of the difficulties involved in its use, we do not recommend treating seed for a large acreage, but rather, to treat a few bushels of seed by this method with which to plant a seed plat in which to produce smut free seed for planting the main crop. This seed plat should be planted as far as possible from any other barley field to avoid infection. The method of treatment is as follows. Three or four gunny sacks are provided and two or three pecks of seed are placed in each sack. A tub of water at ordinary temperature, about 60 or 70 degrees F, is conveniently placed and the sacks of barley are immersed for 4 hours. This is for the purpose of penetrating the seed and rendering it a better conductor of heat than it would be if dry. Meanwhile a large kettle or wash boiler of water is provided and heated to exactly 129 degrees F. The temperature can be determined by using a float-

ing dairy thermometer. Each sack of seed is immersed for 10 minutes. The temperature is maintained by pouring in small amounts of hot water from time to time. The seed is then emptied from the sacks and spread out to dry. It is clear from the above description that this method is not very practical on the average farm, but it is not more difficult than many other operations that are commonly carried out, and will pay well for the trouble if there is any considerable loose smut infection.

Seed Improvement.

Seed improvement work or barley breeding has been in progress at Brookings since 1912, at Newell since 1908 and at Highmore since 1909. The object has been to increase the yield of varieties that were known to be desirable and adapted to South Dakota conditions. Various factors influence the yield. Among these may be mentioned, resistance to rust, resistance to lodging, rapidity of maturing and ability to stool vigorously. Several hundred selections of the Odessa, Hannchen, White Smyrna, Manchuria and Gatami have been made. Seed from these selections has been grown in row trials in comparison with the original or bulk seed of the same variety. A few of the best of these selections have been retained and placed in field trials in comparison with other varieties but the greater number of these selections have been discarded from time to time as not being enough better than the original varieties to warrant continuing them in the tests. This eliminating or discarding is absolutely necessary to prevent the cereal breeding work from growing beyond our ability to handle it. But it is a difficult matter and we often feel that we may have discarded something of value after we get through eliminating from a season's breeding plat. A rule which we have followed unless the selection possessed some special quality which we wished to preserve has been to discard every selection that did not produce at least 10 per cent more grain than the bulk seed of the same variety grown under similar conditions.

We now have the following selections in field trials at Brookings: Odessa Selection 24 of 1910, Manchuria S. D. 105 (Minn. 105) Selection 27 of 1912 and Manchuria S. D. 102 (Minn. 6) Selection 27 of 1912 and Selection 11 of 1910. At Highmore the following selections are retained in the field trials; White Smyrna Selections 7, 14, 19 and 27 of 1915. Thus far none of the barley selections have been increased for distribution, but the ones named are promising and after having been subjected to a longer test, it is possible that some of them may be increased and distributed.

Station Seed Distribution.

It has been the policy of the experiment station to use the best varieties known at the time in planting all crop rotation, fertilizer, rate of seeding, date of seeding, tillage and other tests of that sort on each experiment farm. The seed thus raised has been thoroughly cleaned and graded and sold direct to farmers for seed purposes. A record has been kept of every pound of seed that has been placed since 1912. A price list is issued December 1st each year and included as a part of the experiment association seed list. This list is sent to members of the experiment association and to all others upon request. Those who receive station seed are requested to report on its behavior and if possible to compare it with some other seed of the same crop in connection with the extension division field crops project. They are also asked to increase the seed if it gives good results and sell the seed to others. They are furnished with a pedigree of the seed, that is, a statement showing the amount of seed purchased, the date and the variety, name and registry number. The tag on the shipment gives the result of a purity and germination test as well as directions for treating the grain to prevent covered smut. The prices charged are approximately market value of the seed plus cost of sacks, cleaning, grading and shipping. Orders are booked on the date received at the State College at Brookings and are furnished in the same order as receiv-

ed until the stocks are exhausted. Shipments are made from the nearest experiment farms where seed is available.

Experiment association seed lists are made up each year from members of that association, who are growing adapted varieties. By this means considerable progress has been made during recent years in the dissemination of seed of adapted varieties.

The Place of Barley in the Rotation.

Barley responds readily to good crop rotation methods. For best results, barley should follow an intertilled crop such as corn. The cultivation, if done thoroughly reduces the number of weeds, conserves moisture and puts the soil in good condition for the barley crop which is sown the following spring. If the intertilled crop has been grown on land that previously produced a leguminous crop such as sweet clover, red clover, alfalfa or peas, the barley receives a further advantage from the residual influence of the leguminous crop.

Results obtained with barley in rotation experiments are summarized in Table XIV. In these experiments the tillage, seed etc. are uniform. There is considerable variation in the soil. For this reason the rotation trials are replicated three times at Cottonwood, Eureka and Highmore and the results reported are averages of the three replications. At Brookings, it has been impossible to repeat the experiments owing to the small amount of land available. The Brookings results are from single tests. This may account for the fact that barley in a rotation of corn, barley and peas yielded 6.9 bushels more than the barley in rotation with corn and red clover rather than to any advantage of the rotation itself and that barley grown continuously has given an average yield for six years but 0.7 of a bushel less than when grown in rotation with corn and clover. It should be noted that in rotations of barley, peas, wheat and barley, millet, wheat, both lacking any intertilled crop, barley produced from 10 to 12 bushels less per acre than when following corn and clover. At Cottonwood, the

TABLE XIV. Yields of Barley in Different Rotations 1912-1917.

Crops in Rotation	Bushels Per Acre						
Brookings Farm	1912	1913	1914	1915	1916	1917	Average
No. 5 Corn, Barley, Clover	47.8	38.6	30.8	61.4	26.7	39.7	40.3
No. 7 Corn, Barley, Peas	54.1	27.3	30.8	60.4	33.3	57.1	47.2
No. 12 Barley, Millet, Wheat	31.2	22.7	21.5	42.5	21.3	32.5	28.7
No. 13 Barley, Peas, Wheat	30.8	18.3	23.1	48.5	19.8	44.2	30.8
No. 16 Barley Continuously	56.0	36.5	26.5	57.7	19.0	41.9	39.6
Cottonwood Farm							
No. 4 Kaoliang, Barley, Sweet Clover	20.3	0.0	6.9	0.0	17.1	11.8	9.2
No. 5 Corn, Barley, Sweet Clover	17.6	0.0	6.6	0.0	18.9	3.0	7.7
Eureka Farm							
No. 2 Corn, Oats, Millet, Barley	3.3	6.2	29.9	60.1	26.9	13.7	23.6
No. 6 Corn, Wheat, Sweet Clover, Millet rows Barley	2.6	6.5	30.6	67.6	32.6	32.2	28.7
Highmore Farm							
No. 4 Corn, Rye, Sweet Clover, Millet Rows, Barley, Peas	0.4	0.0	24.4	50.7	27.4	13.4	19.9
No. 7 Alfalfa, Corn, Oats, Barley	0.4	0.0	24.9	48.2	24.2	20.5	19.7

rotation experiments are on very poor land. This together with the dry weather and hail accounts for the low yields obtained. At Eureka, barley following intertilled millet in a rotation of corn, wheat, sweet clover and millet in rows, yielded 5.1 bushels more per acre than when following millet seeded in the usual way, a rather striking illustration of the value of cultivation preceding the barley crop.

While the evidence available indicates that barley may be grown continuously on rich land with considerable success for several years in the eastern part of the state, it is worth while to recall that there are advantages in crop rotation, as compared with continuous cropping among which are better labor distribution and weed-control.

A few examples of good rotations may be suggested as follows:

1. For the eastern section:
   Corn, barley, field peas or peas and oats.
   Corn, barley, oats and sweet clover.
   Corn, barley and sweet clover.
   Corn, barley, oats, alfalfa six years.
2. For the central and western section.
   Corn, barley.
   Fallow, barley, oats.
   Corn, barley, sweet clover.
   Fallow, winter rye, corn, barley, sweet clover.
   Corn, barley, (alfalfa several years.)

Preparation of the Seed Bed

It is usually better to apply barnyard manure a year or two before barley is to be sown than directly before because of the danger of securing too rank a growth of straw with the resulting lodging and attendant evils. This can be done very conveniently if a good rotation system is practiced, as the manure can be spread on the alfalfa, clover or grass land which will later be plowed up for corn to be followed by barley.

A number of experiments in the use of manure and

various commercial fertilizers are in progress on the station farms. The results of these are to be reported in detail by the soils division of this department and are therefore omitted here. In general, these results clearly indicate that barley responds readily to applications of suitable crop food in the rotation, especially in the eastern section where the soils have been more or less depleted by the farming methods, thus far pursued.

If barley is to follow other grain the land should be disked as soon as possible after harvest. This preliminary disking puts the land in better shape to be plowed. Plowing should be done as early in the fall as possible. The plowing need not be excessively deep. Four or five inches is sufficient providing that the land is in a good rotation and is plowed deeper for the corn or other intertilled crop. In the spring the land should be harrowed as soon as it is possible to get on the land. Usually another harrowing just before the grain is sown is sufficient to put the seed bed in a good condition. If the soil is quite loose it is worth while to harrow it and pack it with a roller, preferably one of the new corrugated type, and then harrow again before seeding or to use a press drill for seeding.

If barley is to be sown on corn ground, the land is usually harrowed as early as possible in the spring, then double disked by lapping half over that previously disked each round and finally harrowed again. This preparation puts the corn ground in good shape for seeding barley as a general rule. The amount of work needed to put corn ground in good shape for barley may be materially reduced if the land has been cultivated in such manner that it is not ridged up and is practically free of weeds or other rubbish. The object is to have the seed bed firm and even with the surface loose enough to permit proper covering of the seed. A loose seed bed is to be avoided as it is not favorable to proper development of the barley roots.

Grass sod land may be used for barley if the sod is broken the previous season during June, July or August

and then worked down well with disk and harrow the following spring. Spring plowing or spring breaking is generally not desirable as the seed bed cannot be put in shape early enough in the spring to permit seeding at the proper time.

Time of Seeding

Barley should be seeded during late March or in April, preferably before the 20th of the month. There are occasional seasons when barley sown later gives good results but as a general rule, every day's delay after May 1st reduces the yield. There is no one thing that will help increase the yield and quality of barley so much as seeding at the proper time. The truth of this statement is well illustrated by the results of experiments as shown in Tables XV and XVI. At Brookings in a three year test, 1913 to 1915, barley sown from April 20th to 25th gave an average yield of 60 bushels per acre. That sown May 1st to 7th produced 46.2 and that sown May 15th to 20th gave 36.8 bushels per acre. It will be noted that the average decline in yield after April 25th was about one bushel per day. At Highmore, a date of seeding test was begun in 1914 with four varieties of barley,

TABLE XV. Annual and Average Yields recorded on a date of seeding test with Manchuria S. D. 105 at Brookings 1913 to 1915.

Date of Seeding	Yield in Bushels per Acre			
	1913	1914	1915	Averages
April 20-25	60.4	53.1	66.6	60.0
May 1-7	50.0	55.2	33.3	46.2
May 15-20	56.3	25.0	29.1	36.8

With the exception of the year 1915, the yields of all varieties decreased as the date of seeding was delayed. That season the Gatami and Odessa were injured by hail while heading out. The White Smyrna was protected by the boot or upper leaf sheath which tends to enclose the head and the Hannchen had not headed out when the hail storm occured. Both of the latter varieties gave the highest average yield from the earliest date of seeding while the Odessa and Gatami produced the highest yields from mid April seeding due to the conditions in 1915 above mentioned. In 1916 the earliest seeding was made on March 16th. This seeding produced the highest yields with all varieties in the test.

TABLE XVI. Annual and average yields recorded in a date of seeding test with Odessa, Gatami, Hannchen and White Smyrna at Highmore 1914-1916.

Variety and Date of Seeding	Yield in bushels per acre			
	1914	1915	1916	Averages
Odessa				
March 16			62.5	
April 1-12	54.2	41.6	58.3	51.4
April 15-22	43.7	83.2	60.4	62.4
May 1-7	43.7	66.6	39.6	50.0
May 15				
Gatami				
March 16			58.3	
April 1-12	62.5	45.8	50.0	52.8
April 15-22	51.0	64.5	47.9	54.5
May 1-7	52.1	66.6	33.3	50.7
Hannchen				
March 16			47.9	
April 1-12		81.1	42.7	61.9
April 15-22		81.1	40.6	60.8
May 1-7		54.1	27.1	40.6
White Smyrna				
March 16			58.3	
April 1-12	45.9	62.4	52.1	53.5
April 15-22	37.5	58.2	47.9	47.9
May 1-7	33.3	58.2	35.4	42.3

It will be noted that the yields did not fall off greatly until seeded after April 20th. From the results now available it seems safe to conclude that barley should be seeded as early as possible but that owing to its ability to mature rapidly it does not suffer seriously from medium late seeding. For that reason, if one has oats, wheat and barley to sow, he may sow the oats first, then the wheat and then the barley.

No serious injury due to freezing in the spring has been noted during the tests. Odessa and White Smyrna have not shown any injury whatever.

Rate of Seeding.

Experiments indicate that barley should be seeded at the rate of from four to seven pecks per acre. The best rates of seeding vary somewhat according to the condition of the land, the locality and the variety grown. Tests have been conducted for a number of years at Brookings, Eureka and Highmore. In these tests the barley was sown on corn ground manured once in four years at Brookings and Highmore and on fall plowed millet stubble at Eureka. The land at Eureka has only been cropped a few years and has not been manured. In all cases the land is kept in good condition and is fairly free from weeds. The results of these tests are reported

in Table XVII. At Brookings seeding six pecks has given the highest net return with Odessa barley though eight pecks has given a slightly greater average yield. The results with Manchuria indicate that the rate of seeding with this variety makes little difference. On rich land it is capable of stooling vigorously and increasing the length of head and size of grain to make up for the thin seeding. As stated this test was on very rich land. For ordinary farm land it is probable that five or six pecks would be a safer rate of seeding than four. At Eureka, the results with Hannchen barley indicate that four pecks is sufficient seed. Seeding eight pecks reduced the yield by 2.1 bushels per acre. The six peck rate did not reduce the average yield materially and in three of the five seasons gave a slightly higher yield than the four peck rate. Our conclusion from the Eureka results is that where the land in this section is in good condition and free from weeds, four pecks of Hannchen barley is sufficient but on average farm land inclined to be weedy, five or six pecks would be better.

At Highmore seeding 7 1-2 pecks increased the yield of Odessa nearly 5 bushels over seeding 4 pecks and in the test with Hannchen, the highest rate of seeding used 8 3-4 pecks produced the largest average yield. With the variety Odessa, it is quite clear that rather heavy seeding about 6 or 7 pecks is best. In the case of Hannchen, the average results are materially influenced by the wet year 1915 when heavy seeding produced by far the best results. In three years out of the four included in the test, seeding 6 1-4 pecks gave the best net returns.

When barley is seeded in a damp condition shortly after treating the seed to prevent covered smut, the drill should be set to sow about a peck more per acre than when the dry seed is used as the moisture swells the grain. No tests have been conducted to determine the rate of seeding hulless barley. It is usually sown at the rate of 6 pecks per acre when sown alone or at the rate of 4 pecks when sown with 2 pounds of rape or 4 pecks of field peas for hay or pasture purposes. The drill is set the same as for sowing wheat.

Fig. 13. Chevalier S. D. 21, a two rowed variety adapted to irrigated farms.

In brief then, six pecks of seed barley seems to be best as a general rule. This amount may be reduced slightly or added to a little under special conditions. Odessa seems to require rather heavy seeding for best results, while Manchuria and Hannchen have given good yields when seeded unusually light. White Smyrna requires rather heavy seeding as the grains are extra large.

Depth of Seeding.

Barley should be seeded about 2 inches deep. The seed may be somewhat deeper in a loose or a dry soil than in a compact or wet seed bed. A depth of seeding test has been conducted at Highmore with Odessa and Hannchen barley. The soil is of a glaciated clay loam type and is usually moist enough in the spring for the seed to germinate promptly. The highest yields in nearly all cases were secured from seeding two inches deep while the average yields are much in favor of this depth. The results of this test are shown in Table XVIII.

TABLE XVII. Annual and average yields in bushels per acre in a rate of seeding test with barley at Brookings, Eureka and Highmore.

Variety and Rate of Seeding	1913	1914	1915	1916	1917	Averages
Brookings						
Odessa S. D. 182						
4 pecks			52.7	8.8	55.4	39.0
6 pecks			56.6	11.9	57.3	41.9
8 pecks			53.9	14.2	58.3	42.1
Manchuria S. D. 105						
4 pecks	70.8	52.1	70.8			64.5
6 pecks	68.7	53.1	70.8			64.2
8 pecks	66.7	53.1	66.6			62.1
10 pecks	68.7	51.0	72.9			64.2
Eureka						
Hannchen S. D. 20						
4 pecks	7.9	30.3	70.0	20.6	7.7	27.3
6 pecks	8.4	30.2	65.2	21.7	9.6	27.0
8 pecks	5.6	29.8	64.2	19.6	6.9	25.2
Highmore						
Odessa S. D. 182						
5 pecks	10.4	47.9	68.6	43.7	31.2	40.3
6 1-4 pecks	9.4	47.9	79.0	45.8	30.2	42.4
7 1-2 pecks	6.3	60.4	77.0	54.2	28.1	45.2
8 3-4 pecks	7.7	47.9	77.0	45.8	31.2	41.9
Hannchen S. D. 20						
5 pecks		41.6	68.6	38.5		
6 1-4 pecks	3.8	56.1	64.6	41.7		41.5
7 1-2 pecks	3.1	48.9	79.0	43.7		43.9
8 3-4 pecks	3.1	54.1	83.2	41.7		45.5

TABLE XVIII. Annual and average yields obtained in a depth of seeding test with Odessa and Hannchen at Highmore 1913-1917.

Variety and Depth of Seeding	Yield in bushels per acre					Averages
	1913	1914	1915	1916	1917	1914-1916
Odessa						
1 inch	3.1	47.9	72.8	45.8	26.0	55.5
2 inches	1.7	47.9	79.0	54.2	32.3	60.4
3 inches	1.7	43.7	77.0	39.6	34.3	53.4
4 inches	3.1	45.7	62.4	41.7	33.3	49.9
Hannchen						
1 inch		43.7	77.0	38.5		53.1
2 inches		56.1	64.6	41.7		54.1
3 inches		41.6	79.0	37.5		52.7
4 inches		47.9	77.0	35.4		53.4

Method of Seeding.

Barley should always be seeded with the grain drill. The seed is thus distributed evenly and is placed uniformly at the proper depth in the soil. Less seed is necessary when it is drilled than when it is broadcasted.

In dry seasons higher yields have sometimes been secured from barley seeded in wide spaced double or triple cultivated rows than from the ordinary method of seeding in drills six inches apart.

At the Cottonwood substation the ordinary method of seeding has been compared with the three-row group method of seeding barley for 3 years. The triple rows were 6 inches apart, with a 30 inch space between each group which was kept cultivated. The results in detail are shown in Table XIX. The average yield for four years including two dry seasons and one favorable one as well as one year in which the crop was destroyed by hail is 9.5 bushels for the ordinary method as compared with 8.4 for the three row groups.

TABLE XIX. Annual and average yields of Gatami barley in a test of spaced cultivated rows compared with ordinary drilling on the Cottonwood substation 1914-1916 inclusive.

Distance Between rows	Yield in bushels per acre				
	1914	1915 (a)	1916	1917	Averages
Single rows 6 inches	4.6	0	22.4	10.8	9.5
Triple rows 30 inches	5.4	0	21.1	7.0	8.4

(a) Hail destroyed the crop.

At Highmore four methods of spacing were included in the test. The grain drill was used in all cases and the different spacings were secured by stopping up part of the holes in the drill. For example, the three row groups 30 inches apart were obtained by plugging four holes and permitting three to run alternating. Thus the rows in the group were each six inches apart, the three occupying 12 inches in width with 30 inches between the groups. The ordinary method gave the highest average yield. The triple rows 6x30 inches gave higher yields per acre than the other spaced rows. In the two dry seasons, 1913 and 1914, this method produced 4 or 5 bushels per acre

more than the ordinary seeding and the quality of grain was better. In favorable and average seasons ordinary drilling was best. The seeding of barley in cultivated rows is not recommended as a general practice in any part of South Dakota where a sufficient acreage of corn or other cultivated crop is grown, but where it is desired to increase the acreage of cultivated crops in order to check weed growth and get the cultural benefits of a cultivated crop, the triple row group method is well worth trying. This would be particularly true for the northern section of South Dakota where corn growing is rather precarious and the tendency is to crop continuously to small grain.

The results of the tests at Highmore are shown in Table XX. Seeding by the three row group method requires a little less than half the seed used for ordinary seeding. The drill is set for the rate wanted, the same as when seeding in the usual way, but four holes out of each seven are stopped up so that less than half the usual amount of seed is required. Two cultivations with an ordinary corn cultivator straddle of the three row groups has been sufficient.

Fig. 14. Hannchen S. D. 20 in three row groups at Highmore illustrating method of using barley as a cultivated crop instead of corn.

TABLE XX. Annual and average yields recorded in a comparison of spaced cultivated rows with ordinary drilling of barley at Highmore 1913-1917.

Distance Between Rows	1912	1914	1915	1916	1917	Average for 5 yrs. 1913-1917
6 inches	1.6	22.6	50.9	25.3	21.8	24.4
12 inches	5.8	18.7	47.3	23.1	17.8	22.5
Double rows 6x36 inches	4.6	22.8	36.7	20.3	13.8	19.6
Triple rows 6x30 inches	5.9	27.7	41.0	22.0	18.9	23.1

Barley as a Nurse Crop

The early two-rowed types of barley such as White Smyrna make an ideal nurse crop for clovers and alfalfa. They make a rapid start in the spring, thus protecting the alfalfa and clover plants from wind injury while small; hold the weed growth in check; ripen early, before the moisture supply is likely to become deficient and furnish a good crop of seed or hay. Care must be taken not to use the large late maturing barleys because of the smothering effect and the excess use of moisture. A good rule to follow is to seed early. In very dry seasons remove the barley for hay if it is taking too much moisture away from the small alfalfa or clover plants. The clover or alfalfa seed can be mixed with the barley and both seeded at once and the seed will be distributed evenly if care is taken in mixing the seeds before placing in the grain drill or the small seed may be sown with a grass seed attachmnt. Usually the drill is set for a peck less barley per acre than when seeding barley alone.

Prevention of Weeds.

Barley is a rather strong growing crop and is able to compete with most weeds. Large numbers of weeds in a field of barley will reduce the yield of grain considerably however. A well prepared seed bed gives the crop an opportunity to grow rapidly and overcome some of the weed pests. Barley following a cultivated crop will be fairly free from weeds. Careful cleaning of the grain with the fanning mill will remove nearly all of the objectionable weed seeds. If the barley is treated in the formalin solution, by the method of pouring the seed into a vat and skimming off the floating material, nearly all of the seeds of wild oats will be removed. The crop matures early thus giving a chance to plow early and kill

large numbers of weeds that mature seed later than the barley as well as to start weed seed which is lying dormant in the ground.

Barley Under Irrigation

The methods of growing barley under irrigation in South Dakota differ somewhat from those practiced in the semi-arid or sub-humid sections. The field must be smoothed or leveled to facilitate irrigation. Field ditches must be prepared after the grain has been seeded. Two irrigations are usually sufficient for a crop of barley. The water should be applied when the soil becomes dry, but before the crop begins to suffer. Ordinarily the crop should be irrigated when the heads are in the "boot" and again when the grain is beginning to "fill." Over-irrigation, or allowing water to stand in the field, will check the growth of barley or cause it to lodge.

Harvesting the Crop

Barley should be cut when the kernels are in the "stiff dough" stage and the straw nearly all turning yellow. The heads of many varieties of barley shatter or break off of the stem if allowed to become fully ripe before being harvested. If a large field of barley is to be harvested the cutting should begin when the kernels have reached the medium dough stage.

Both the binder and header are used for harvesting barley in South Dakota but the former is much more common. The barley cut with the binder should be carefully shocked so as to minimize the amount of bleaching and discoloration of the kernels from exposure to rain and sun. Barley should always be stacked as soon as dry in the shock. Early shock threshing usually results in barley that bin burns or is too wet to make a good market grade. Early stacking is advisable as the dry straw absorbs any surplus moisture and the barley after going through the "sweat" comes out a nice clear color. The barley will become discolored and may sprout if left standing in the shock too long. Barley is more subject

to loss in quality and market grade from exposure than any other cereal. When all the expense, loss of time and inconvenience of shock threshing is considered, stack threshing is cheaper than shock threshing. It pays to cap the barley stacks with a thick layer of old hay as this saves loss due to rain and it is also a good plan to use dry straw for a base for the barley stack to avoid loss of quality in the lower bundles due to absorbing moisture from the ground . It should always be borne in mind that the market prices of barley are largely determined by the quality of the sample, as shown by its color, plumpness and odor.

LIST OF AVAILABLE BULLETINS.

Annual Reports, 1915, 1916, 1917

Bulletins

106. Sugar Beets in South Dakota.

107. Sheep Scab.

129. Growing Pedigreed Sugar Beets in South Dakota.

130. Some New Fruits.

131. Scabes (Mange) in Cattle.

132. Effects of Alkali Water on Dairy Products.

140. Selection and preparation of seed potatoes.

143. Roughage for Fattening Lambs.

142. Sugar Beets in South Dakota.

144. Preliminary Report on the milking machine.

145. A report of Progress in Soil fertility Investigations.

147. Effect of Alkali Water on Dairy Cows.

148. Corn Silage and Mill products for Steers.

149. Some Varieties and Strains of Oats and their yields in So. Dakota.

151. Trials with Sweet Clover as a field Crop in South Dakota.

152. Testing and Handling Dairy Products.

153. Selecting and Breeding Corn for protein and oil in So. Dak.

154. The Pit Silo.

155. Selection and Preparation of Seed Potatoes.

156. Kaoliang, A New Dry Land Crop.

157. Rape Pasture for pigs in Corn field.

158. Proso and Kaoliang for table use.

159. Progress in Plant Breeding.

160. Silage and Grains for Steers.

161. Winter Grain in So. Dak.

162. First Annual Report of Vivain Experiment and Demonstration Farm.

163. Comparative Yields of Hay, from Several Varieties and Strains of Alfalfa, at Brookings, Highmore, Cottonwood and Eureka.

164. Making butter and cheese on the farm.

165. Corn Silage for lambs.

166. Important Factors affecting milking machines.

167. Transplanting alfalfa.

168. Breakfast Foods and their relative value.

169. Flax Culture.

170. Quack Grass Eradication.

171. Cream Pateurization.

172. Grasshoppers and their control.

173. Sugar Bets in So. Dak..

174. Sorghums for Forage in South Dakota.

175. The Role of Water in a Dairy Cow's Ration.

176. Potato Culture.

177. The Sheep.

178. Injurious Corn Insects.

179. Emmer in South Dakota.

180. Root Crop Culture.

181. Corn Culture.

182. Corn Silage for steers.

NOTE—We do not add the names of non-residents to the regular list.