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Wheat in South Dakota

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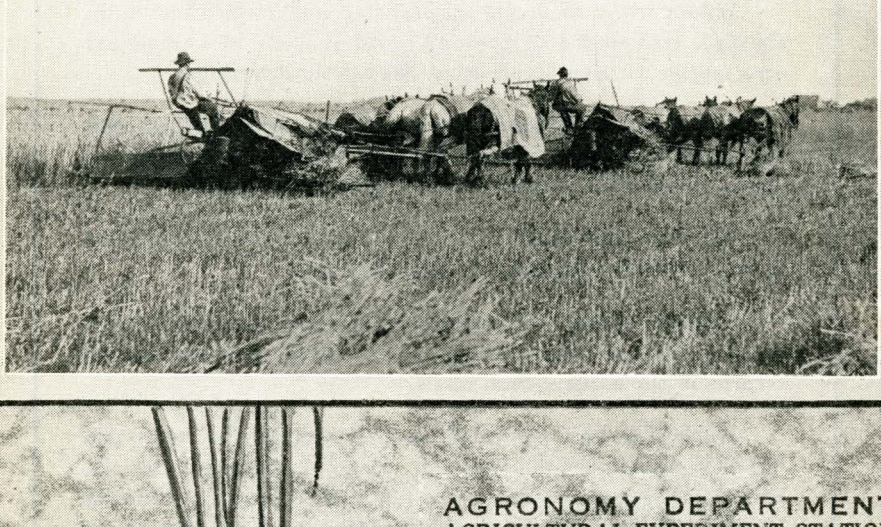

AGRONOMY DEPARTMENT
AGRICULTURAL EXPERIMENT STATION
OF THE
SOUTH DAKOTA STATE COLLEGE
AGRICULTURE AND MECHANIC ARTS
BROOKINGS S. DAKOTA

Digest

South Dakota produces about thirty million bushels of wheat annually. This consists of hard red spring, durum and hard red winter wheats.

Marquis is the most desirable spring wheat for milling purposes but Kota and Ruby have outyielded Marquis in the variety tests at the South Dakota State College experiment stations of Brookings and Highmore. Turkey S. D. 144 has given the highest yields and survives the winters better than the other varieties of winter wheats tested. Among the durum wheats, Kubanka is wanted by the millers but in the variety tests this variety has yielded less than Acme, Monad, and Mindum.

Winter wheat seeded in the standing corn yielded 20.0 bushels while that seeded on plowed ground yielded 11.5 bushels per acre, at the College Experiment Station at Brookings.

Spring wheat seeded in March or early April has less rust and yields more than if seeded later. Winter wheats give the highest yield when planted the first part of September.

The yield and quality of wheat can be increased by growing it in a rotation containing a cultivated crop.

Common spring wheat seeded at six pecks per acre, durum seven pecks, and winter wheat at five pecks gave the largest returns in the experimental trials.

Black stem rust and stinking smut are the two worse diseases of wheat in South Dakota. Early planting and the use of resistant varieties reduces the loss caused by rust. Stinking smut can be controlled by thorough cleaning and treating of the seed.

Wheat in South Dakota

E. W. HARDIES[1] and A. N. HUME

South Dakota ranks second in the production of durum wheat, third in the production of spring wheats and tenth in total production off wheats. In yields per acre, South Dakota ranks lower than it should. The yield per acre, and consequently the net profit per acre, can be increased by good cultural practices, better crop rotations, planting adapted varieties, and by the control of diseases.

Many wheat growers are also lamenting the fact that the quality of wheat grown has gradually decreased during recent years. This is caused mainly by the enormous increase of weeds, the mixing of varieties and the lack of control of diseases. Good cultural practices, good rotations, and disease control not only increase yield per acre but also improve the market quality at the same time.

Production

The annual production of wheat in the world is about three and one-half billions of bushels. Of this amount ,the United States produces over 800 million bushels or about one-quarter of the world's production.

Considering the distribution of wheat in this country, we find that Kansas and North Dakota are the two leading states. The state of South Dakota ranks tenth with a production of about thirty million bushels. Of this amount, a little more than half is hard red spring wheat.

The wheats grown in South Dakota are common or "bread" wheats, and durum or "macaroni" wheats. The following illustrates how these classes are divided:

Wheats Grown in South Dakota

Common or "bread"
1. Hard red spring
   a. Marquis
   b. Kota
2. Hard red winter
   a. Turkey
   b. Kanred

Durum or "macaroni"
1. Amber
   a. Kubanka
2. Red
   a. Pentad

The two main divisions are "bread" and "macaroni" wheats. The common wheats grown in this state are either hard red spring or hard red winter wheats. The durums are subdivided into amber and red durum. The hard red spring wheats are of the greatest importance in South Dakota.

Distribution of Wheats in South Dakota

A study of the production of wheat shows that certain localities are high while others produce very little wheat. Figures I to V show how the wheats are distributed in the state[2].

Figure I shows the production of hard spring wheat in this state by counties. The counties leading in production are Spink, Brown, McPherson, and Campbell. A map showing the large producing counties does

1-Acknowledgment is hereby given to the North Dakota Agricultural Experiment Station for the use of the picture on the cover page.

2-Credit for data from which these maps were constructed is hereby given to Bureau of Livestock and Crop Estimates.

not tell the whole story. Besides knowing the total production of hard spring wheats one must also know what position such wheats hold as compared with the total production of wheat in the various counties.

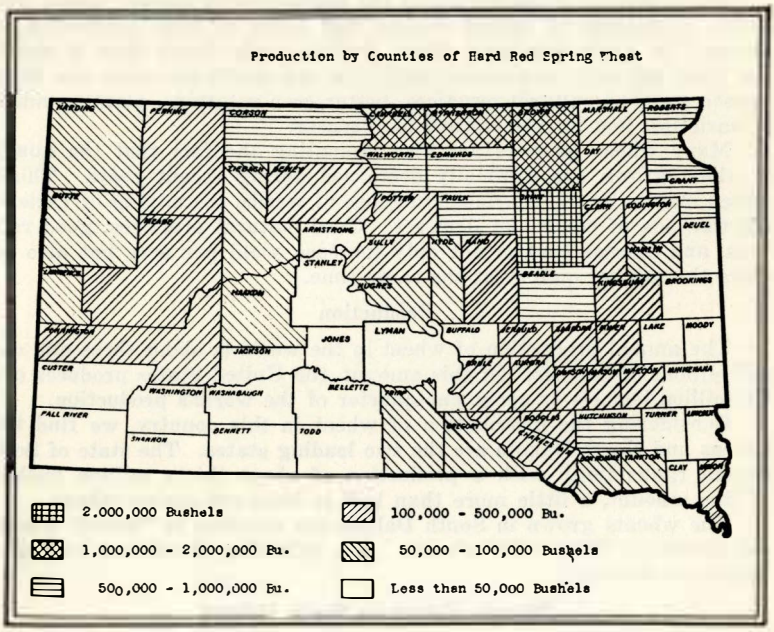

Fig. 1.—The northeastern counties of the state produce large amounts of common spring wheat. Spink, Brown, McPherson and Campbell counties each produce more than 1,000,000 bushels.

Figure II shows the percentage of hard red spring wheat as compared to the total wheat grown in each county. Comparing Figures I and II, one may note that although a county may be high in total production it need not necessarily be high in percentage of hard spring wheats as compared with the total wheats in that county. Taking Brown County for example: Figure I shows that it is one of the four highest counties in production of hard spring wheats. Although this county produces large amounts of common spring wheat, this wheat occupies less than 25 per cent of the wheat produced in that county (Figure II).

Comparing the production by counties of hard red spring wheats with the production of durum wheats (Figures I and III) one finds that several counties produce large amounts of both classes. Wheat is the main crop of these counties. Most of the durum wheat is produced in the northern half of the state.

A study of Figure IV shows that durum wheats occupy an important part in the northern and central sections of the state. This class of wheat is more drought and alkali resistant than the common wheats and consequently is grown on lands receiving limited rainfall.

The winter wheats are of prime importance in the southeastern counties (Figure V). Here winter wheat fits in well in the rotation with corn. The rainfall is sufficient to give the plants a good growth in the fall and thus enables them to withstand the winters.

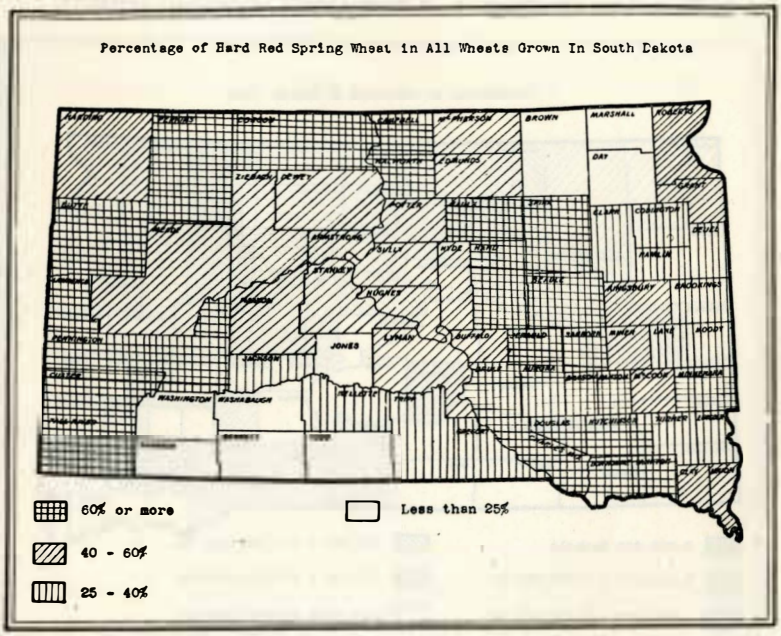

Fig. 2.—Hard red spring wheat is the most important wheat grown in South Dakota. It predominates in the majority of the counties.

Wheat Districts in South Dakota

It is impossible to make an outline of South Dakota that would show every section of the state in which each of the three classes of wheat predominates. One can only make a general outline showing the distribution and adaptations of wheat classes in South Dakota.

DISTRICT I:—Within this district is found the hard red winter wheat of the state. It is here that the winter wheats are of first importance and can be successfully grown in a rotation with corn. By using a one-horse drill and seeding the wheat in the corn stalks during the first half of September, very little winter killing results. The Missouri, James, Vermilion, and Sioux River Valley lands produce excellent winter wheat yields. On the experiment station at Brookings, winter wheat planted in the corn field in fall yielded 20.0 bushels per acre for a twelve-year period, and seldom is there a total loss due to winter killing. On the plats where winter wheat was planted on plowed ground, there is always more or less winter killing and in severe years nearly all of the plants are killed. These plots averaged 11.5 bushels during the same twelve years.

The hard red spring wheats are second in importance in District I, especially along the western border. The growing of durum wheat should not be attempted because of the soft starchy kernels that develop under the rainfall of this district. The entire district except the northern part lies in the section receiving 25 or more inches of rainfall annually.

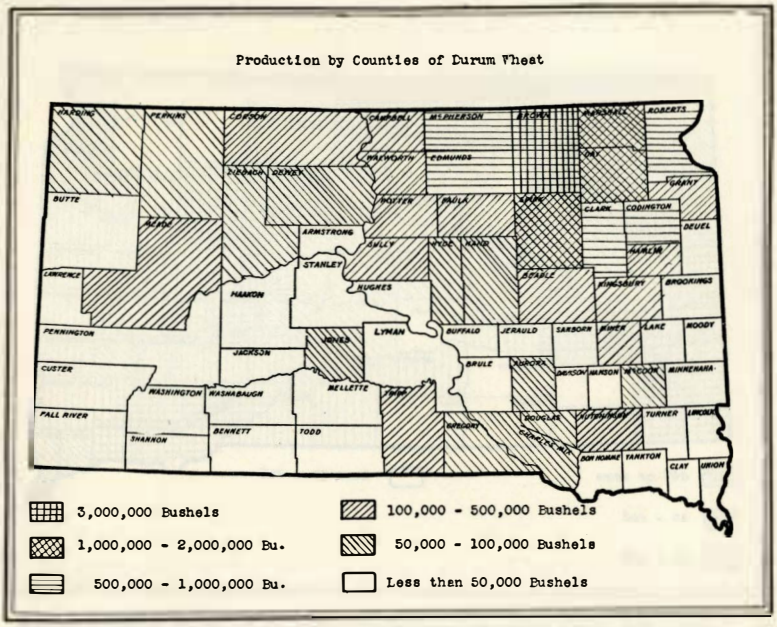

Fig. 3.—Brown, Marshall, Day, and Spink counties lead in the production of durum wheat. Most of the durum wheat is grown in the northern half of the state.

DISTRICT II:—This is the Hard Red Spring Wheat District. In this district, the hard red spring wheats predominate. Winter wheats can be grown along the southern and eastern border and along the river valleys farther north, when proper cultural methods are used. Along the northern and western borders of this section where the rainfall is less, and at higher elevations, durum wheat gains in importance.

DISTRICT III:—In the remaining part of the state, the soil and topography vary so much that no one type of wheat is adapted to the entire region. Taking the area as a whole, the hard red spring and durum wheats are about equal in importance.

The hard spring wheats are grown mostly on the lower fertile valley lands of the eastern and central parts of this district, wherever the soils, rainfall, and general growing conditions are favorable. The durum wheats are best adapted to the entire western part of the state except the Black Hills and in the valley lands. At the State College Experiment Station located at Eureka, the durum wheats yielded an average of 18.5 bushels per acre as compared with 13.6 bushels for common wheat as an average for eight years.

It has already been shown that the wheats grown in South Dakota come under three classes. The more important varieties of each class that are grown in this state will now be described.

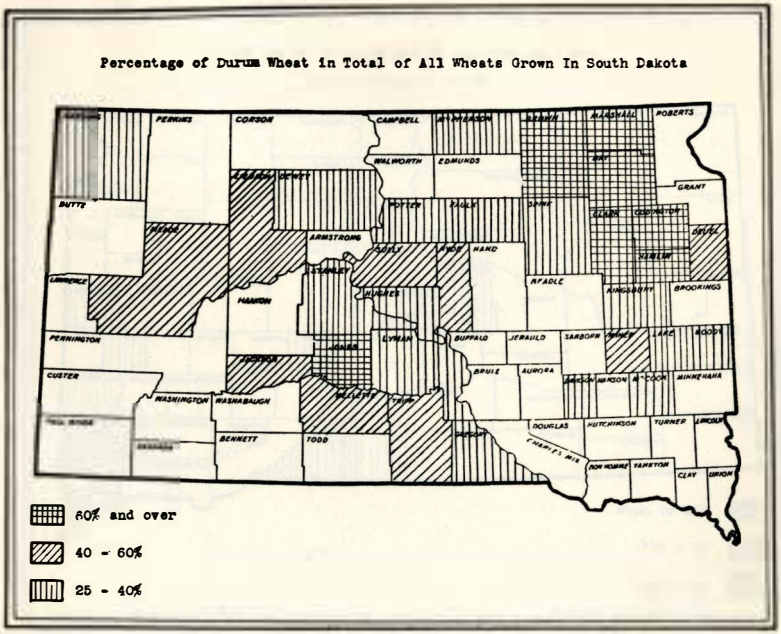

Fig. 4.—Durum wheat is the most important wheat grown in the northeastern and central counties. When this wheat is grown in the southeastern part of the state, the kernels are usually soft and starchy.

Varieties of Hard Red Spring Wheat

MARQUIS:—This is the most important variety of its class. It has excellent milling and bread making qualities and is used as the standard of comparison for hard red spring wheats. It is resistant to stinking smut or covered smut but is susceptible to black stem rust. It has hard, red, short kernels, dense awnless spikes, and matures fairly early. In regions where black stem rust is not a severe factor, Marquis is a high yielder.

KOTA:—A bearded variety, maturing later than Marquis. It is resistant to a number of forms of black stem rust and is also somewhat drought resistant, but is susceptible to loose and covered smuts, and also leaf rust. The kernels are red, hard, and long, resembling winter wheat. In milling qualities, it is generally considered inferior to Marquis.

PRESTON:—Commonly called Velvet Chaff. A midseason, midtall, awned variety. The chaff is free from hair and not pubescent as the name "velvet chaff" would indicate. It is more susceptible to stem rust than Marquis and also a lower yielder.

BLUESTEM OR HAYNES BLUESTEM:—This was a very popular variety but has now almost disappeared. It is a late, fairly tall variety;

spikes are awnless, glumes pubescent(covered with fine hair); has excellent milling qualities. It is more susceptible to stem rust than Marquis.

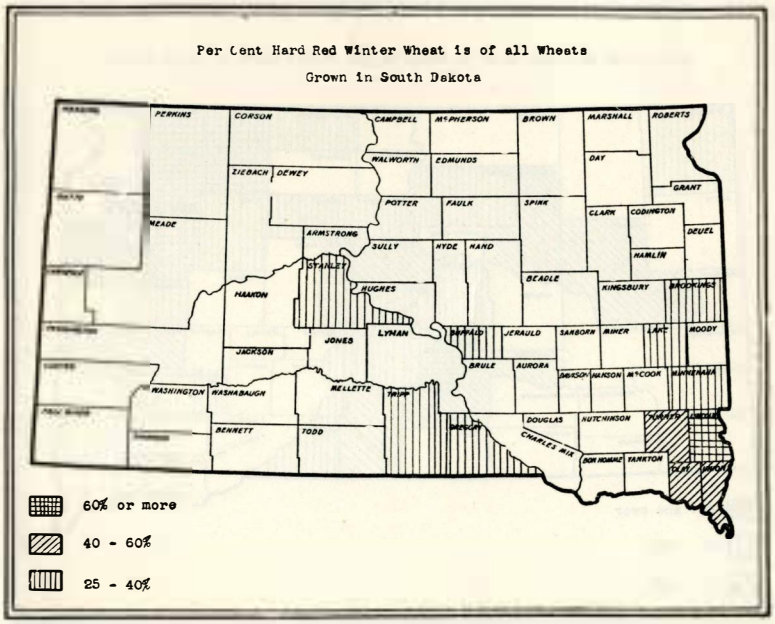

Fig. 5.—The winter wheats are mostly grown in the southeast counties and along the Missouri river. More than sixty per cent of all wheat grown in Lincoln county is winter wheat.

RUBY:—A variety very similar to Marquis except that it is shorter in straw and matures several days earlier. Because of its early maturity it often escapes rust and gives good yields.

CERES:—A promising variety from a Kota and Marquis cross. This variety has given excellent results where tried but has not yet been distributed in South Dakota.

QUALITY:—More commonly known as Burbank's Quality. This is a hard white wheat and belongs to an entirely different market class than the varieties mentioned above. The kernels are hard and white. The plant is rather short, matures early, and has awnless spikes. The kernels shatter more than Marquis. It is not a high yielder; neither is it rust resistant. If this variety becomes established it will result in further mixing of wheat classes and in a lower grade and price for all wheats.

Varieties of Durum Wheats

KUBANKA:—This is the most popular variety of durum wheat grown. It is a midseason, tall variety; stems white, spikes dense, awned; kernels white (amber), large, hard; a high yielding, excellent milling variety and used as the standard of comparison of durum wheats.

ACME:—A pure line selection from Kubanka, difficult to distinguish from its parent. It is more rust resistant than Kubanka and consequently yields more. An objection to this variety is that it produces a dull grayish product.

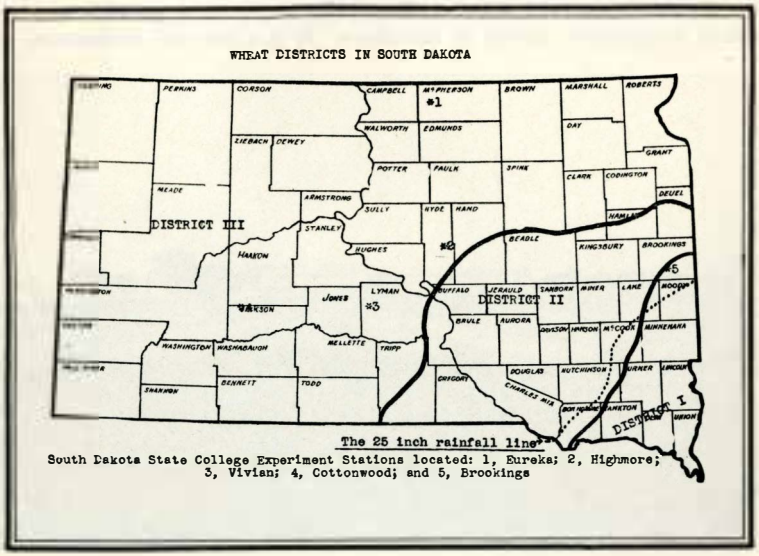

Fig. 6.—Winter wheat is the most important wheat in District I; common spring wheat in District II; common spring and durum wheats are of equal importance in District III.

MONAD, D-1:—This variety can hardly be distinguished from Acme. It is rust resistant and also produces a grayish manufactured product. Both Acme and Monad are more rust resistant than Kubanka but produce an inferior product. They have become popular because of their yielding ability under rust conditions. Where stem rust is not a severe factor, they should be replaced by Kubanka because a large amount of these varieties may depress the market for all amber durums.

MINDUM:—This is a midseason variety, having slightly weak straw, and somewhat rust resistant. The variety has given good yields in the trials at Highmore and Brookings.

NODAK:—A selection from Kubanka and very similar to it. This variety has proven to be more rust resistant than its parent and has given good yields in the few trials made in South Dakota.

PENTAD:—This is also known as D-5, RUSTPROOF and RED DURUM. The kernels are distinguished from the amber durums in that they are dull red in color instead of white or amber. The beards and chaff are nearly white. This is the most rust resistant variety grown. From the manufacturing standpoint, red durum has the poorest quality. Its principal use is for plant breeding purposes because of its rust resistance. A mixture of red durum in amber durum materially reduces the price of the amber durum. Only in bad rust years does it yield better than the other durums.

Varieties of Hard Red Winter Wheats

Although South Dakota is not a large producer of winter wheats, a considerable acreage of these wheats is grown in the southeastern part of the state.

TURKEY or TURKEY RED:—This is the most popular and most widely distributed variety of this class. It is a bearded midseason, mid-

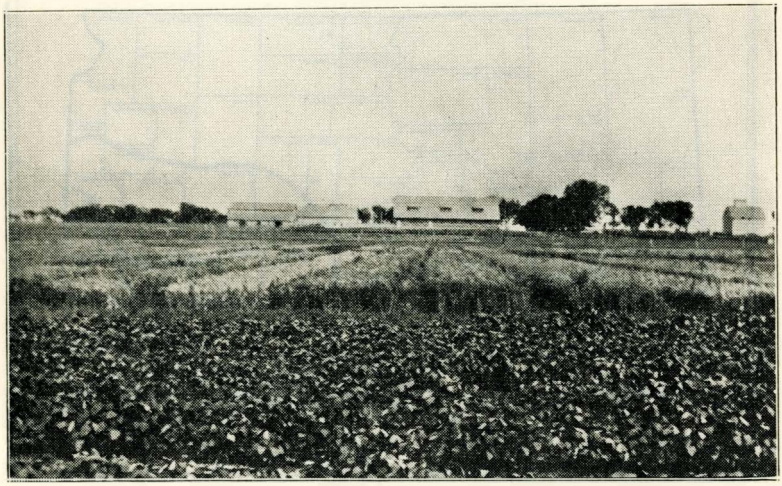

Fig. 7.—WHERE VARIETIES ARE TESTED
A part of the State College experiment station at Brookings devoted to the testing of varieties of small grains.

tall, variety; kernels are hard and dark red; resistant to drought and to covered or stinking smut; it is also relatively winter-hardy and has excellent milling and baking qualities.

KANRED:—This resulted as a pure line selection from Turkey and can be distinguished from it by having longer beaks on the glumes or outer chaff. In South Dakota it has not shown itself to be superior to Turkey.

Conducting Variety Trials

If one were to list all the varieties of wheat grown in the United States the number would be very large. It has already been said that the climatic conditions are the important factors that determine the class of wheat grown in a certain area. After a careful study of the climate, the majority of varieties can be eliminated from testing in any state. It is one of the works of the Agronomy Department to test out new varieties and compare them with those that are already established. In making the tests, the following factors are taken into account: yielding ability, disease resistance, market quality, time of maturity, drought resistance, stiffness of straw, and winter hardiness. An ideal wheat would be one that ranked high in all these points. A variety that excels in all has not been developed as yet, but it is the hope of the agronomist who is constantly working towards such a goal. There are three meth-

ods that can be used to improve the varieties of small grains: by introducing new varieties, by selection, and by crossing and thus combining the desirable factors of two or more varieties in the development of a new one that is superior to both of its parents.

The methods used in testing is to sow the varieties side by side in plats and on as uniform land as can be found. Each of these plats is about one-fiftieth acre. The entire series of plats is then replicated a number of times. Extensive variety trials are conducted by the South Dakota State College experiment stations at both Brookings and Highmore. At the Cottonwood and Eureka stations the number of varieties included in the tests are not as large. Figure VI shows the location of the State College experiment stations in South Dakota.

Yields of Varieties of Wheat

The following tables show the yields of different varieties of wheats tested. For convenience in comparing the yields of the varieties, they are grouped into the different classes.

TABLE I.—YIELDS IN BUSHELS PER ACRE OF THE VARIETIES OF COMMON SPRING WHEATS IN THE TEST AT BROOKINGS AND HIGHMORE.

BROOOKINGS—

	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	Av. 1915 to 1920	Av. 1921 to 1925
Marquis	25.0	7.2	14.7	22.3	3.3	3.3	7.5	10.0	4.2	27.1	13.0	12.6	12.4
Ruby	...	...	...	...	...	...	5.8	9.2	5.4	29.2	20.5	...	14.0
Kota	...	...	...	...	5.8	3.3	13.3	14.2	8.3	26.4	21.5	...	16.7
Prelude	25.0	11.1	11.9	22.5	2.5	5.0	5.8	12.5	5.0	25.9	12.2	12.3	12.7
Red Bobs	...	...	...	...	...	...	6.6	5.8	1.7	19.8	15.5	...	9.9
Kitchner	...	...	...	...	...	...	6.6	10.0	1.3	20.8	5.8	...	8.9
Disco	...	...	...	...	...	...	5.0	8.3	6.7	25.9	21.3	...	13.4
Quality	...	...	...	...	...	...	...	...	4.6	23.4	19.6	...	...
Bluestem	14.2	0.6	10.0	10.1	0.4	0.0	0.0	...	...	...	...	5.9	...
Pioneer	29.1	8.9	14.7	22.5	5.0	0.9	0.0	0.0	...	...	...	13.5	...
Preston	21.6	7.5	12.8	15.4	0.8	0.0	...	...	...	...	...	9.7	...
Ceres	...	...	...	...	...	...	...	...	...	...	22.5	...	...

HIGHMORE—

	1917	1918	1919	1920	1921	1922	1923	1924	1925	Average 1921 to 1925
Marquis	14.1	20.8	10.3	6.7	1.3	18.3	9.6	28.6	12.5	14.1
Ruby	...	...	...	...	4.6	24.2	18.8	27.6	11.5	17.3
Kota	...	...	...	4.7	0.7	21.7	21.3	27.5	15.2	17.3
Prelude	5.8	12.1	14.8	2.7	2.1	18.3	12.5	23.8	...	...
Kitchner	...	...	...	2.7	4.2	17.1	8.8	...	...	...
Bluestem	9.6	13.3	1.1	1.3	3.3	12.5	12.8	23.3	7.9	11.9
Pioneer	8.7	18.3	10.3	6.7	5.4	19.2	19.2	26.3	13.8	16.8
Preston	12.9	20.6	7.8	4.7	3.3	16.2	15.4	22.5	12.7	14.0
Ceres	...	...	...	...	...	...	...	...	16.9	...
Red Bobs	...	...	...	0.0	5.4	18.3	13.8	25.0	9.0	14.3

In looking at the average yields from 1921 to 1925 inclusive, one observes a wide variation between the yielding ability of different varieties. Besides observing an appreciable difference at any one station, one also finds that varieties behave differently in different localities. For example, Pioneer averages 16.8 bushels per acre at Highmore compared with 14.1 bushels for Marquis during the years 1921 to 1925. At Brookings, Pioneer yielded very low for a number of years and it was finally

omitted from the variety test. Bluestem and Preston behave in a similar way; they yield fairly well at Highmore but both have been omitted from the tests at Brookings because of their low yields. Marquis, Ruby, and Kota are three prominent varieties; Marquis because of its fair yields and unsurpassed milling qualities. Ruby and Kota will be taken up later under a discussion of rust infection and time of maturity.

TABLE II—YIELDS IN BUSHELS PER ACRE OF VARIETIES OF DURUM WHEATS IN THE TESTS AT BROOKINGS AND HIGHMORE.

BROOKINGS—

	1918	1919	1920	1921	1922	1923	1924	1925	Average
Kubanka	30.8	9.3	6.7	2.8	5.8	7.5	21.7	34.2	14.8
Acme	33.3	8.3	11.7	17.5	16.6	7.5	22.9	37.6	19.4
Monad	30.0	9.1	6.7	15.4	24.1	8.7	21.1	36.7	18.9
Pierson	30.0	6.6	2.5	8.3	9.1	6.7	16.7	41.7	15.2
Arnautka	25.8	1.6	1.6	....	10.0	4.6	19.6	43.3	15.2
Mindum	32.5	7.5	4.0	3.3	20.8	7.5	20.9	42.1	17.3
Pentad	30.0	10.0	6.7	13.3	....	....	....	....	....
Nodak	....	....	....	....	....	....	21.3	37.6	....

HIGHMORE—

	1918	1919	1920	1921	1922	1923	1924	1925	Average
Kubanka	12.9	15.4	2.8	8.3	29.2	22.8	21.5	17.9	16.4
Acme	18.3	17.5	14.6	7.0	30.0	23.8	22.6	20.8	19.3
Monad	14.6	15.8	13.2	7.0	30.0	25.0	....	....	....
Pierson	21.2	3.8	12.1	8.3	27.5	20.9	20.6	18.8	16.7
Arnautka	16.7	2.5	0.0	....	10.8	24.2	15.9	....	....
Mindum	28.3	8.6	11.0	8.7	26.7	24.2	22.1	17.5	18.4
Nodak	....	....	....	....	....	....	....	16.9	....

In the variety tests of durum wheats at Brookings and Highmore, the highest yields were secured from Acme. If yields were the only factor to be considered, this variety would be the best one to grow. It has already been stated that a variety must not only be a high yielder but it also must meet the requirements of the wheat manufacturers.

Nearly all of the durum wheats are used in the making of macaroni and similar products in which a white color is desirable. Acme and Monad, both of which are high yielding and rust resistant, produce grayish products and do not impart the qualities desirable in good manufactured products. Kubanka is the favorite durum wheat and is used as the standard of comparison by millers and experiment station workers. It is more susceptible to rust than Acme and Monad and consequently is a lower yielder. All three of these varieties are very similar in plant and seed characters and difficulty is experienced in distinguishing them. The fact that they are so hard to tell apart is a handicap to both the farmer and the manufacturer. The miller is mostly interested in the production of good quality crops; but in addition to this the farmer needs a large yield per acre to make farming profitable. A limited quantity of wheats such as Acme and Monad can be produced and marketed without materially affecting the price of durum wheat; but if such varieties predom-

inate, the market price of all durum wheats becomes reduced. Many millers are objecting to the present large acreage of these varieties and are of the opinion that the manufactured products from durum wheats in this country will soon meet with less favor because of lower quality products than were made in the past. Mindum has yielded well in the tests at both stations. This variety belongs to the Arnautka group, having rather tall weak straw. In milling qualities it is slightly inferior to Kubanka.

TABLE III:—YIELDS IN BUSHELS PER ACRE OF SOME VARIETIES OF WINTER WHEATS IN THE TESTS AT BROOKINGS AND HIGHMORE.

BROOKINGS—

	1920	1921	1922	1923	1924	1925	Average
Turkey S. D. 144	24.1	21.7	40.8	23.3	43.3	33.4	31.1
Kanred	23.3	31.7	25.8	13.3	60.9	25.0	30.0
Kharkof	6.7	25.8	45.8	21.6	55.0	32.5	31.2
Minturki	20.0	18.3	29.2	19.2	38.3	40.0	27.5
Minhardi	0.0	5.4	22.5	8.3	23.3	30.9	15.1

HIGHMORE—

	1920	1921	1922	1923	1924	1925	Average
Turkey S. D. 144	0.0	7.9	45.0	0.0	45.9	10.4	18.2
Kanred	0.0	5.8	48.7	0.0	44.6	7.1	17.7
Kharkof	0.0	8.7	48.3	0.0	42.9	5.8	17.6
Minturki	0.0	2.9	44.2	0.0	45.7	12.5	17.5
Minhardi	0.0	5.8	38.9	0.0	33.4	10.8	14.8

The hard red winter wheats can be successfully grown in parts of South Dakota. Turkey S. D. 144 has given the highest yields at both Brookings and Highmore. This is an excellent milling and baking wheat. It is resistant to drought and relatively winter-hardy. Although not as resistant to some forms of rust as Kanred, it has given higher yields. During severe winters, considerable winter killing results at Highmore, and for two years, 1920 and 1923, total winter killing resulted on all plats. At Brookings, winter wheats when sown in the corn fields with a one-horse drill have given very high yields. This has already been mentioned in the discussion under hard red winter wheats.

Varieties Vary in Winter Hardiness

The amount of winter killing is one of the big factors in the growing of winter wheats. The first requirement of a winter wheat adapted to South Dakota is that it must survive the winters with a minimum of winter killing.

The behavior of varieties in regard to winter killing varies in different localities. A variety may be very winter hardy in one locality but only moderately so in a different locality. Table IV shows the winter survival of varieties of wheats at Brookings and Highmore.

TABLE IV:—PER CENT OF STAND IN SPRING OF FIVE VARIETIES OF WINTER WHEATS AT BROOKINGS AND HIGHMORE

BROOKINGS—

	Turkey 144	Kanred 1098	Kharkof 191	Minturki	Minhardi
1920	95	100	85	95	100
1921	60	90	90	100	100
1922	100	100	100	95	100
1923	90	90	85	80	10
1925	95	90	90	98	98
Ave.	88	94	90	94	82

HIGHMORE—

	Turkey 144	Kanred 1098	Kharkof 191	Minturki	Minhardi
1920	0.0	0.0	0.0	0.0	0.0
1921	100.0	82.0	90.0	50.0	85.0
1922	100.0	100.0	100.0	100.0	100.0
1923	0.0	0.0	0.0	0.0	0.0
1924	100.0	100.0	95.0	95.0	98.0
1925	75.0	5.0	10.0	50.0	90.0
Ave.	63.0	48.0	49.0	50.0	62.0

From Table IV it can be seen that the stand of winter wheat in spring is much higher at Brookings than at Highmore. At both places, the winter wheat is sown in corn stubble, either with a one-horse drill before the corn is cut or with a two-horse drill if the corn has been cut and removed before seeding time. The region represented by Highmore is not generally adapted for the production of winter wheats. The winters are severe and the snow covering is often too light to protect the wheats from winter killing. Turkey S. D. 144 survived the winters better than any other variety at the Highmore Experiment Farm during the six years. The winters of 1920 and 1923 were very severe and resulted in total winter killing of all varieties at Highmore. At Brookings, Turkey S. D. 144 came through the winters with a good stand every year except 1921 when only 60 per cent of a stand was reported. The cause of this poor stand was not explained; it might be due to lower germination or to a poorer location than the other varieties or to some other factor. In spite of this poor stand and consequently low yield for this one year, Turkey S. D. 144 outyielded all other varieties during the six years as shown in Table III.

Comparative Yields of Different Classes of Wheat

In the discussion of the wheat districts of South Dakota, it was stated that certain wheats were adapted to certain localities. Let us now study the yields secured from the three classes of wheats at Brookings and Highmore.

Figure VIII shows the relative yields of common spring, durum, and winter wheats during a five-year period (1921-1925) at Brookings and Highmore. The yields of four varieties: Marquis, Ruby, Kota, and Red Bobs of common spring wheats; four varieties of durum wheats: Kubanka, Acme, Pierson, and Mindum; and five varieties of winter wheats: Turkey, Kanred, Kharkof, Minturki, and Minhardi, were averaged during this period at each of the two stations. It is easily observed that at Brookings the winter wheats outyield the other wheats by a considerable margin. The southeastern part of this state is better adapted for the

production of winter wheats if proper cultural methods are used, than for the production of common spring or durum wheats. The durum wheats rank second in yield at Brookings but the climate is not adapted for the production of good quality durum wheats.

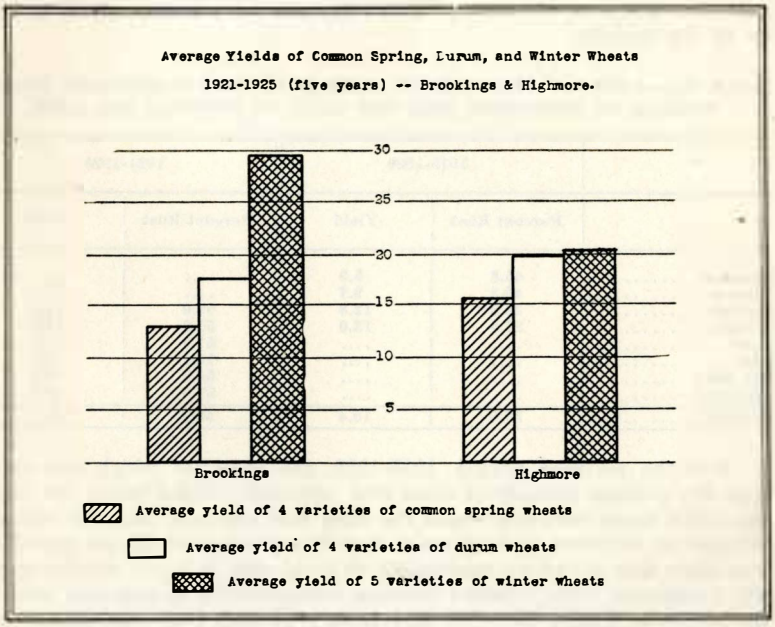

Fig. 8.—Winter wheat, seeded in corn. yields twice as much as common spring wheat in the tests at Brookings. At Highmore, winter wheat winter kills often and is not a dependable crop. Here durum and common spring wheats bring about equal returns from the land.

At Highmore, there is very little difference between the yields of durum and winter wheats. The production of winter wheats is hazardous and some years results in total failure. (See Table III.) The durum and spring wheats are of equal importance in this section. Although the durum wheats outyield the common spring wheats, their market value is usually lower so that in value per acre there is not so great a difference.

Table V gives the yields of the three classes of wheats used in constructing Figure VIII.

TABLE V:—FIVE-YEAR AVERAGE YIELD IN BUSHELS PER ACRE OF FOUR VARIETIES OF COMMON SPRING, FOUR OF DURUM, AND FIVE OF WINTER WHEATS AT BROOKINGS AND HIGHMORE

	Common Spring	Durum	Winter
Brookings	13.2 bu.	17.5 bu.	29.4 bu.
Highmore	15.7 bu.	19.9 bu.	20.6 bu.

Effect of Rust and Time of Maturity on Yields

A striking difference may be observed in the yields of the different varieties of wheats in the preceding tables. This difference in yield is due to several factors among which are: the amount of black stem rust and other diseases, the time of maturity, and the inherent yielding ability of the variety.

TABLE VI:—AVERAGE PER CENT OF STEM RUST ON VARIETIES OF SPRING WHEATS AT BROOKINGS, AND THE YIELD IN BUSHELS PER ACRE

	1915-1920		1921-1925	
	Percent Rust	Yield	Percent Rust	Yield
Bluestem	45.8	5.9	....	....
Preston	40.8	9.7	....	....
Marquis	36.2	12.8	59.0	12.4
Prelude	27.5	13.0	55.0	12.3
Ruby	....	....	51.0	14.0
Kota	....	....	16.4	16.7
Red Bobs	....	....	50.0	9.9
Kitchener	....	....	58.0	8.9
Average	37.6	10.4	48.2	12.4

For the six-year period, 1915-1920, the varieties which had more than the average amount of stem rust infection yielded below the average, while those varieties where the stem rust was less than the average per cent of infection yielded more than the average of all the varieties. It is clear that a variety susceptible to stem rust, is a low yielder under rust conditions. The relation between susceptibility to rust and yield is also shown in Figure IX. The data from 1915-1920 show the relationship between infection of stem rust and yield better than the data from the later years. This is due to the introduction of new varieties, of which Kota is rust resistant and a good yielder, while Red Bobs and Kitchner show a lower rust infection than Marquis and are also lower yielders. Here is a case where the inherent yielding ability of a variety is evident. Marquis is quite susceptible to rust but has a factor which tends towards high yields, while the other two varieties mentioned are slightly less susceptible to stem rust but do not have the inherent yielding ability which is found in Marquis. This goes to show that the power to resist or escape diseases is only one of the factors necessary to secure large yields.

Another factor which affects the amount of stem rust, and consequently the yield, is the time required to mature the crop. As a rule, stem rust becomes more severe as the season advances, and the more time required to mature a variety the more severe will be the rust infection and consequently a reduced yield. The relationship between time to maturity, rust infection, and yield is shown in Figure X. The figure clearly shows the relationship that exists between time of maturity, severity of stem rust infection and yields. Bluestem is the latest maturing variety. It also has the largest per cent of rust infection and produced the lowest yield. Marquis and Preston are two earlier maturing varieties and have a lower rust infection and higher yield than Bluestem.

Prelude is early maturing and often escapes rust. The yields of this variety are low and do not seem to be caused by the rust since it has the lowest amount of infection of all of the varieties mentioned. The low

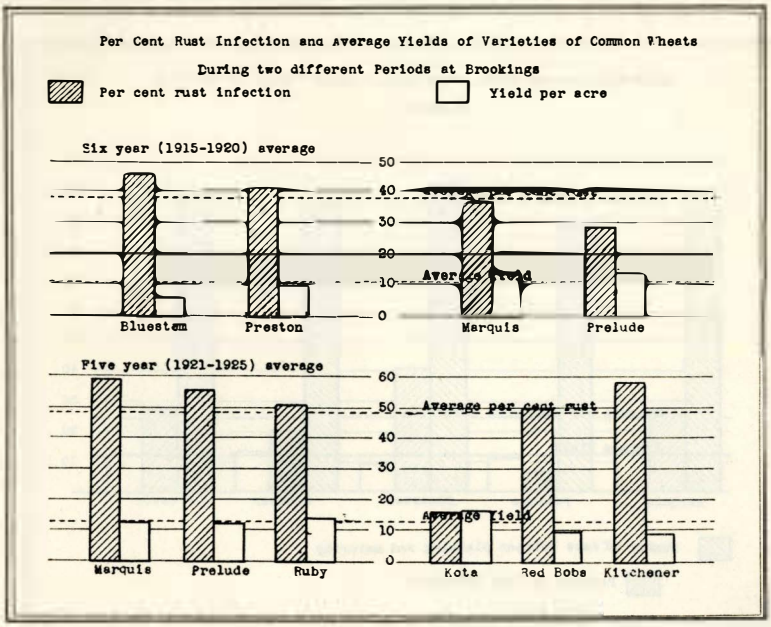

Fig. 9.—Black stem rust reduces the yield of wheat. Varieties that have large amounts of rust are low yielders. Planting varieties that are rust resisting or rust escaping increases the profits from wheat growing.

yields of this variety are to be explained by the low inherent yielding power and its unadaptability.

Preparing the Seed Bed

On farms where a definite rotation of crops is followed, it is the practice to seed wheat after a cultivated crop, usually corn. In regions where corn is not grown to any extent and small grains are practically the only crops grown, several different ways of preparing the seed bed are practiced. At the Eureka substation, several different methods of preparing the seed bed are being tried. Table VII gives the yields for seven years secured from different methods of soil preparation.

TABLE VII:—SEVEN YEARS AVERAGE, 1919-1925, OF WHEAT FROM DIFFERENT METHODS OF SOIL PREPARATION AT EUREKA.

Wheat, summer fallow	18.5 Bushels
Continuous wheat, spring plowed	17.5 Bushels
Continuous wheat, fall plowed	14.7 Bushels
Continuous wheat fall plowed every third year and disced other two years	13.1 Bushels
Wheat, checked corn	19.6 Bushels
Wheat, drilled corn	21.8 Bushels
Wheat, sweet clover, checked corn	19.2 Bushels
Wheat, listed corn	20.7 Bushels

In the rotation where wheat follows corn, the land was double disced and harrowed before seeding wheat. The lowest yield was secured from the continuous wheat plot which was plowed every third year and disced the other two years. This represents the least amount of work that was

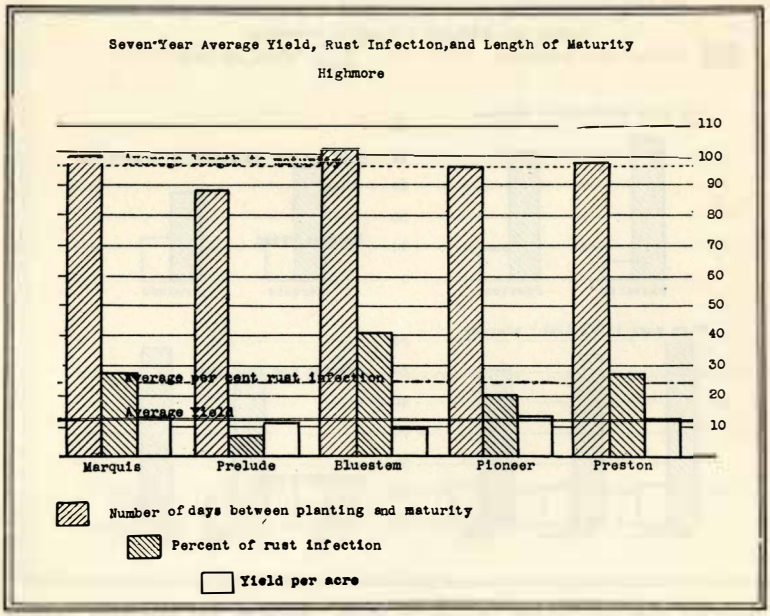

Fig. 10.—Plant wheat early in spring and use early maturing varieties for best yields. Black Stem rust gets more severe as the season advances. The late maturing varieties and late plantings usually have the most rust.

given any field, and is reflected in the low yields secured, 13.1 bushels per acre. The next lowest yield was secured from the continuous wheat plot that was fall plowed. Spring plowing of continuous wheat increased the yield almost three bushels over fall plowing. Summer fallowing every other year increased the yield up to 18.5 bushels. This small increase due to summer fallow makes it very evident that it is not economical. This increase is far from sufficient to pay for the loss of a crop every other year and the labor required to summer fallow. In the rotations where wheat followed corn, the yields increased appreciably. The corn land was double disced and harrowed in the spring before seeding wheat. The largest yield was secured where wheat followed drilled corn. This may be due to the extra amount of snow caught by the stubble from corn drilled in rows over that caught by stubble from checked corn. Since listed corn is in rows the same as drilled corn, it seems plausible that the increase of wheat following drilled and listed corn over checked corn is due to the fact that the soil moisture is increased by the snow being caught in larger amounts where the corn stubble is in rows instead of being in hills.

The yield of wheat in a three year rotation consisting of corn, wheat, and sweet clover, was slightly less than where wheat follows corn. This does not mean that sweet clover is harmful but that under the conditions represented at Eureka wheat in a rotation containing sweet clover does not profit by that legume. At Brookings, the wheat in the continuous wheat plot yielded 8.9 bushels, in the corn-wheat rotation 16.4 bushels, and in the corn-wheat-sweet clover rotation 16.8 bushels per acre.

Time of Seeding

Under the discussion of rust infection and yield it has been observed that the time of maturing is an important factor in the escape of stem rust and consequently of yield. The time that grains mature can be controlled to a considerable extent by seeding time. Excluding climatic factors, wheats that are seeded early mature early. In the date of seeding tests conducted at Highmore, the earlier plantings outyielded those made later.

TABLE VIII:—YIELDS FROM COMMON SPRING AND DURUM WHEATS WHEN SEEDED AT DIFFERENT DATES AT HIGHMORE.

COMMON SPRING WHEAT

	Mar. 1	Mar. 15	Apr. 1	Apr. 15	May 1	May 15	June 1
1917	....	....	....	19.1	17.5	8.7	....
1918	15.0	16.8	16.8	15.8	14.1	9.2	....
1919	....	....	13.1	12.1	6.5	3.1	....
1920	....	....	15.0	....	7.5	5.0	....
1921	8.3	9.6	8.3	5.4	2.5	....	....
1922	....	....	20.8	24.2	11.7	8.3	1.9
1923	....	....	20.0	20.0	11.0	5.8	0.0
1924	....	33.3	35.8	28.8	19.3	13.3	....
Avge.	11.7	19.9	18.5	17.9	11.3	7.6	0.9

DURUM WHEAT

	Mar. 1	Mar. 15	Apr. 1	Apr. 15	May 1	May 15	June 1
1917	....	....	....	23.5	15.0	5.8	....
1918	8.3	20.8	10.8	8.3	10.8	10.0	....
1919	....	....	21.1	21.6	15.8	7.1	....
1920	....	....	25.8	....	14.6	6.6	....
1921	11.3	10.4	11.7	8.3	2.5	....	....
1922	....	....	28.3	36.7	21.7	15.0	7.1
1923	....	....	28.3	25.3	24.1	17.0	5.8
1924	....	29.0	22.5	25.6	25.8	10.0	....
Avge.	9.8	20.1	21.2	21.3	16.3	10.2	6.5

The results in Table VIII emphasize the importance of early seeding. March and early April seedings give the largest yields of common spring wheats. Every delay in seeding means a lower yield. In the durum wheats, the yield does not drop off until the seeding is delayed after the middle of April. The table points out that spring wheats should be sown as early as possible in the spring in order to secure the highest yields.

Large differences in yield are also observed by seeding winter wheats at different dates. Table IX shows the results at Brookings and Highmore in the date of seeding test.

TABLE: IX—YIELDS IN BUSHELS PER ACRE OF WINTER WHEATS WHEN SEEDED AT DIFFERENT DATES.

HIGHMORE

1917	July 15	Aug. 1	Aug. 15	Sept. 1	Sept. 15	Oct. 1	Oct. 15	Nov. 1	Nov. 15	Dec. 1
1917	.0	.0	.0	.0	.0	.0	.0	7.0	15.0	8.2
1918	.0	25.0	.0	15.8	16.2	18.3	34.3	....	....	....
1919	29.5	Destroyed		24.3	29.6	21.7	17.6	15.0	4.8	....
1920	.0	.0	.0	.0	.0	.0	.0	....	....	....
1921	1.7	6.7	9.6	9.2	11.3	6.7	5.8	5.8	5.8	3.3
1922	46.6	57.5	55.8	57.5	55.0	40.8	31.7	31.7	27.5	9.2
1923	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1924	45.8	47.5	51.6	53.4	48.4	47.5	29.1	25.0	17.5	9.2
1925	4.2	7.1	11.2	12.9	12.9	7.5	3.3	5.0	5.0	2.1
Avge.	14.2	17.9	16.0	19.2	19.3	15.8	13.5	12.8	10.8	5.3

BROOKINGS

	Aug. 15	Sept. 1	Sept. 15	Oct. 1	Oct. 15	Nov. 1
1922	40.4	30.8	29.6	21.2	26.2	16.7
1923	21.7	24.5	20.0	20.0	16.7	11.7
1924	....	66.7	50.9	26.7	16.7	18.3
1925	30.9	32.9	40.0	44.2	30.9	24.2
Avge.	31.0	38.7	35.1	28.0	22.7	17.7

At both Highmore and Brookings, the largest yields of winter wheat were secured from seedings made the first part of September. Wheat that is planted at this time makes a good fall growth and is able to survive the winters better than that from later plantings. Nothing is to be gained from planting before September 1.

Rate of Seeding

At Highmore in the rate of seeding trials with common spring wheats over a seven-year period, the highest yield was secured from seed-

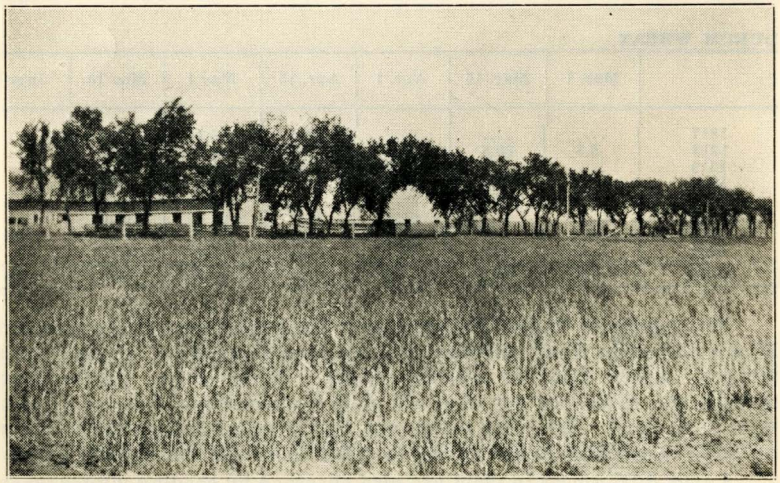

Fig. 11.—A GOOD STAND OF WINTER WHEAT

Seeding winter wheat in standing corn with a one-horse drill insures good winter protection and a good yield. This is a good way to sow winter wheat in South Dakota.

ing eight pecks per acre. The difference between the yields scured from seeding eight pecks, 15.8 bushels; and six pecks, 15.5 bushels, is insignificant and amounts to less than the difference between 8 and 6 pecks. From Table X it is quite evident that the most profitable rate of seeding common spring wheat in the region represented by Highmore is six pecks per acre.

TABLE X:—YIELDS IN BUSHELS PER ACRE OF COMMON SPRING WHEAT WHEN USING DIFFERENT AMOUNTS OF SEED, HIGHMORE.

YEAR	4 Pks.	5 Pks.	6 Pks.	7 Pks.	8 Pks.
1917	9.1	10.0	12.9	12.5	13.7
1918	18.3	22.5	25.8	25.0	23.3
1920	8.3	7.5	8.3	7.5	10.8
1921	3.1	4.2	4.2	4.6	4.6
1922	19.2	20.8	22.5	23.3	22.5
1923	12.9	11.7	14.8	13.8	14.2
1924	9.5	21.6	19.8	23.3	21.6
Avge.	11.5	14.0	15.5	15.6	15.8

With durum wheats, the largest returns were secured by seeding at the rate of seven pecks per acre in the tests at Highmore Experiment Farm. The plats seeded to seven pecks gave an average yield of 19.4 bushels per acre during the seven years. The six peck rate of seeding yielded 18.5 bushels or nearly one bushel less per acre than the seven pecks seeding.

When using different amounts of seed in the tests with winter wheat at Brookings, it was found that the most profitable returns were secured from seeding five pecks per acre. Nothing is to be gained by seeding more than this amount.

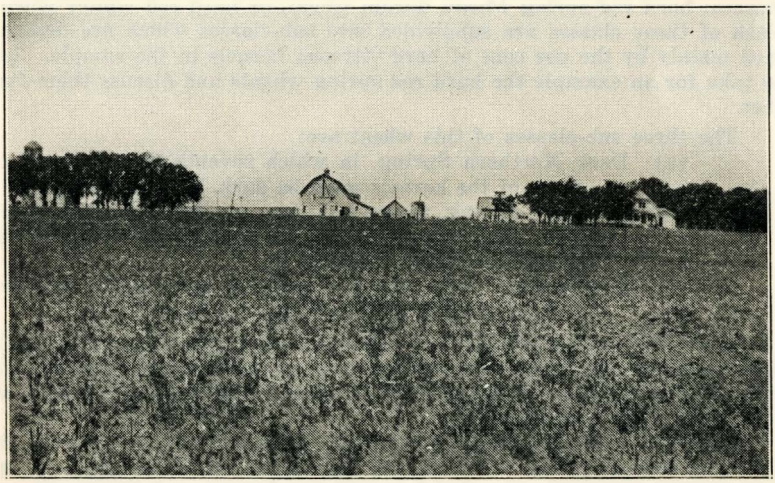

Fig. 12.—A POOR STAND OF WINTER WHEAT

Winter wheat seeded on plowed land winter kills. This field was seeded on the same day and on a joining plot to that shown in Fig. 11. The only difference between them is the method of seeding.

TABLE XI:—YIELDS IN BUSHELS PER ACRE OF DURUM WHEAT WHEN USING DIFFERENT AMOUNTS OF SEED, HIGHMORE.

YEAR	4 Pks.	5 Pks.	6 Pks.	7 Pks.	8 Pks.
1917	8.3	10.7	11.8	11.0	11.0
1918	13.3	16.7	15.0	16.7	10.8
1920	15.0	14.2	15.8	19.2	15.8
1921	2.5	2.5	5.4	2.5	2.9
1922	35.8	36.7	38.3	38.3	37.5
1923	23.3	24.6	25.0	26.3	30.8
1924	15.8	17.5	18.5	21.6	20.0
Avge.	16.3	17.5	18.5	19.4	18.4

TABLE XII:—YIELDS IN BUSHELS PER ACRE OF WINTER WHEAT WHEN USING DIFFERENT AMOUNTS OF SEED, BROOKINGS.

YEAR	2 PKS.	3 PKS.	4 PKS.	5 PKS.	6 PKS.	7 PKS.
1914	26.7	28.3	30.8	30.8	28.3	28.3
1915	43.3	42.5	43.3	40.0	35.0	37.5
1917	15.0	18.3	19.1	18.3	12.5	12.5
1918	30.0	40.0	36.7	44.2	46.7	48.3
1919	10.8	12.5	15.0	18.0	18.3	16.6
1920	22.5	21.7	25.8	25.0	27.5	27.5
1921	8.3	12.5	13.3	17.5	19.2	20.8
1922	27.5	31.3	36.7	37.9	37.1	37.9
1923	5.0	7.5	9.2	13.7	16.7	15.8
1924	33.7	36.7	35.0	35.9	35.9	33.7
Avge.	22.3	25.1	26.5	28.1	27.7	27.9

Market Classes and Grades

All wheats grown in South Dakota belong to one of the following classes: hard red spring wheat, durum wheat, or hard red winter wheat. Each of these classes are subdivided into sub-classes which are determined mainly by the per cent of hard vitreous kernels in the sample. Let us take for an example the hard red spring wheats and discuss them further.

The three sub-classes of this wheat are:

(a) Dark Northern Spring, in which seventy-five per cent or more of the kernels must be dark, hard and vitreous.

(b) Northern Spring, where less than seventy-five percent but more than twenty-five per cent of the kernels must be dark, hard and vitreous.

(c) Red Spring. This sub-class contains twenty-five per cent or less of dark, hard and vitreous kernels.

These sub-classes are given in order of their commercial value. It is easily seen that the higher the per cent of dark, hard and vitreous kernels in a sample of wheat, the greater is its value. Flintiness in wheat is an indication of its milling value.

Each sub-class is further divided into grades of which there are six including sample grade. The factors that decide in which grade a certain sample of wheat comes are: weight per bushel, per cent moisture, damaged kernels, foreign material other than dockage, wheats of other classes, condition with regard to heating, sourness, or mustiness, and the presence of small inseparable stones and cinders.

Every farmer can raise the grade of wheat by good cultural practices and by good care of the grain after it is harvested to prevent it from sprouting, moulding, or being heated. The total amount of dockage shipped in wheat each year is appalling. This is a great economic waste. It costs just as much to thresh, load and ship a pound of dockage as a pound of wheat. Dockage also takes up valuable space in cars and helps produce a shortage of cars at a time when cars are needed to ship the grain. Most of the dockage is separated from the wheat at the mills, ground and resold to farmers as stock feed.

Another common cause of low prices is mixtures of wheats. The common bread wheats and durum wheat are used for different purposes and require different milling processes. The common wheats usually sell for a higher price than the durum wheats; but when the higher price common wheats are mixed in a durum wheat, the mixture sells for less than the pure durum. Likewise a mixture of durum in common wheat lowers its market value. It is therefore very important that one uses seed that is free from weed seeds and wheats of other classes. A good crop rotation helps to rid the land from weeds.

Diseases of Wheat

Like every other plant, wheat has a large number of diseases. Two of the most severe and most widely distributed diseases of wheat are black stem rust and stinking or covered smut. Enormous losses are caused each year from these two diseases.

The relation between black stem rust and low yields has already been discussed in preceding pages. For a more thorough study of this disease, the reader is referred to bulletins listed in the appendix. The methods used to combat stem rust are eradication of the common barberry bush, growing resistant varieties, and planting early so that the grain is harvested before the rust epidemic becomes severe.

Stinking smut of wheat causes loss in that the wheat kernels are replaced by smut balls. This disease is spread through the seed. The smut balls break at threshing time liberating enormous numbers of little spores. These microscopic spores adhere to the outside of the healthy kernels and when planted infect the young seedling. This causes the entire plant to be infected and every kernel to be displaced with smut balls.

From knowledge of the life cycle of stinking smut, it is easy to observe that by planting clean seed no smut will appear in the field. The control of this disease is clean seed and seed treatment. Several methods of seed treatments are bing used of which the formaldehyde method and dust treatments are the most common. Before treating the seed, it should be thoroughly cleaned so as to remove all the smut balls.

The formaldehyde treatment can be done by several methods. The dip method consists of dipping the seed in a solution of one pint of commercial formaldehyde to forty gallons of water. It is then spread out and covered with canvas or blankets for two hours. In the sprinkle method, one pint of formaldehyde is used to fifteen gallons of water; the wheat is shoveled in layers in a bin or wagon box over which the solution is sprinkled. The entire pile of wheat is then shoveled over several times so that each kernel is moistened with the solution. The grain is covered

for two hours. The third method is the concentrated formaldehyde method. Equal parts of formaldehyde and water are sprayed over the wheat with an atomizer while the grain is constantly being shoveled over and over. Then it is covered for two hours. The objection to the formaldehyde treatments is that the dip and sprinkle methods leave the seed wet so that it is hard to keep it from heating, freezing or sprouting. The concentrated method is disagreeable to use and may kill the germination of the wheat.

During recent years, much wheat has been treated with various dusts of which copper carbonate is the most common one used. Dusting the seed is a simple operation and can be done at any time of the year. From two to three ounces of finely pulverized dust are enough to coat all of the kernels in a bushel of wheat. It is very important that the entire kernel be thoroughly coated with the dust.

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