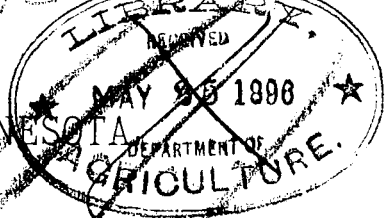
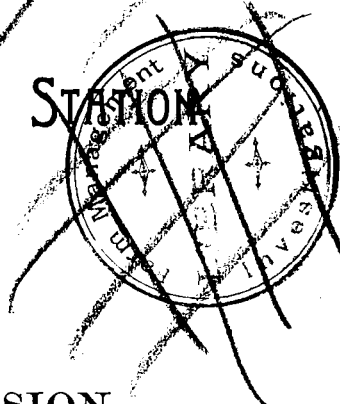


UNIVERSITY OF MINNESOTA



AGRICULTURAL EXPERIMENT STATION



BULLETIN NO. 46.

AGRICULTURAL DIVISION.

DECEMBER, 1895.

- FORAGE AND GRAIN CROPS.
- CROSS ROTATION EXPERIMENTS.
- SMUT IN WHEAT.
- THREE ANNUAL WEEDS.
- TILLAGE EXPERIMENTS.
- METEOROLOGICAL RECORDS.

ST. ANTHONY PARK, RAMSEY COUNTY,  
MINNESOTA.

HARRISON & SMITH, PRINTERS, MINNEAPOLIS.

# UNIVERSITY OF MINNESOTA.

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☞ The Bulletins of this Station are mailed free to all residents of the state who make application for them.

## FORAGE AND GRAIN CROPS.

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WILLET M. HAYS.

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The season of 1895 was favorable to the production of large crops in almost all sections of Minnesota, the averages for the entire state for all crops being the largest produced for many years. Wheat and other small grains were especially productive; the yields of hay from the cultivated and native meadows were large, though in many instances the stand of grass had not well recovered from the injuries received from the serious drouth of 1894. Comparatively little clover was raised owing to the general failure to procure a stand of that seeded in the dry year of 1894. In 1895 much grass and clover was sown and in nearly all instances the fields went into the winter showing a superior stand. The annual fodder and root crops were also large throughout the state. Pastures, too, produced a good yield of food throughout nearly the entire year. On University Experiment Farm almost all crops were excellent; and the farm as now divided up into fields, series and plots, with appropriate roads and alleys between, and with trimmed borders and neat stakes, presented an attractive appearance. Good tests resulted in almost all experiments. On Coteau Farm where experiments have been under way for two years on the homestead of O. C. Gregg, Superintendent of the State Farmers' Institutes, the crops were fair, though the rain was neither so ample nor so regular as at University Farm. There the experiments were more successful than in 1894, though in a few instances the lack of rainfall or our lack of knowledge of the soils produced results which are not valuable except in connection with duplicate results from further trials. The one

class of experiments which was very exceptional was that with the tame grasses and clovers. A most excellent stand has been secured on several dozens of plots, both at Coteau and at University Farm, whereas for several years the results from this class of experiments were very meager. The expert assistance being grown up by our school and college courses has been even more efficient than last year and by joining the work of experimentation with the school and college training most valuable men are being prepared which will insure the execution of large results in education and investigation. Mr. Andrew Boss, foreman of the University Farm, had general charge of most of the details of the experiments herein reported on University Farm, and has done much of the work of compiling the tables resulting from both farms. Mr. T. A. Hoverstad, Assistant in Agriculture at Crookston, planted the field crop work conducted at Coteau Farm in Lyon County in 1895, but assumed the local management of the Northwest Sub-Experiment Farm in July and spent the remainder of the season developing that farm for experiment work. Mr. William G. Smith succeeded Mr. Hoverstad in charge of the experiments at Coteau Farm. Mr. Warren W. Pendergast did very efficient work in the field crop nursery and Messrs. Robt. W. Clark, F. F. Pratt and John Hoffman did much intelligent and careful work. Our thanks are due to Supt. O. C. Gregg for his cooperation and inspiration in the experiment work at Coteau Farm. And now that experiments on his farm are settling down into definite well organized lines, concerning the conservation of moisture and other questions of tillage, the production of forage and the growth of trees, most useful results are anticipated.

Much of the work with breeding, rotating and the cultivation of crops, the testing of perennial grasses and of clovers, of tillage and of the conservation of moisture in the soil and other lines requiring extended scientific research is progressing nicely, but will not be ready to report for some time. The two new sub-experiment farms will greatly aid in the above named lines and in the production of new varieties of crops, in finding new uses for old crops, the ways of producing cheaply the green summer foods for stock and in various other lines will prove of value to the work of the entire station.

## CORN—VARIETY TESTS.

In 1895 the variety tests of corn reported on in 1894 were continued and 69 varieties were included, most of these were grown both at University Experiment Farm and at Coteau Farm in Lyon County. As these varieties are grown rather for the purpose of finding new samples of seed from which to make new, improved, large yielding varieties to disseminate, a report is here made of only the best yielding varieties of the several classes. In Table LX, many of the facts regarding yield and other qualities of each kind are noted.

TABLE LX.—CORN.—Variety Tests.

| University No. | VARIETY.              | Height of stalks,<br>feet. | Per cent. stools. | Per cent. blades. | Height of ears. | Days maturing. | Coteau, 1895. | Yield of<br>stover. |       | Yield of grain.     |       |       |
|----------------|-----------------------|----------------------------|-------------------|-------------------|-----------------|----------------|---------------|---------------------|-------|---------------------|-------|-------|
|                |                       |                            |                   |                   |                 |                |               | University<br>Farm. |       | University<br>Farm. |       |       |
|                |                       |                            |                   |                   |                 |                |               | 1894.               | 1895. | Coteau, 1895.       | 1894. | 1895. |
|                | Yellow Dent.          |                            |                   |                   |                 |                |               |                     |       |                     |       |       |
| 13             | "University No. 13"   | 6.6                        | 10                | 79                | 27              | 107            | 1.53          | 1.92                | 1.38  | 40.7                | 44.5  | 50.6  |
| 18             | Long Seed             | 7.                         | 13                | 83                | 36              | 108            |               | 4.91                | 2.15  |                     | 58.9  | 51.2  |
| 24             | Cosgrove's            | 6.5                        | 15                | 80                | 31              | 107            | 1.05          | 2.65                | 1.60  | 41.3                | 56.3  | 59.4  |
| 30             | New York              | 5.5                        | 37                | 82                | 24              | 105            |               | 2.87                | 2.07  |                     | 43.3  | 59.9  |
| 69             | Lamont                | 6.5                        | 10                | 86                | 36              | 106            |               | 1.51                | 1.51  |                     |       | 67.4  |
| 72             | Wiltzbacher           | 6.7                        |                   | 85                | 30              | 105            |               |                     |       |                     |       | 80.2  |
| 74             | White Cap             | 6.5                        |                   | 83                | 33              | 106            |               |                     |       |                     |       | 53.7  |
|                | Mixed or Calico Dent. |                            |                   |                   |                 |                |               |                     |       |                     |       |       |
| 15             | Lepley's Calico       | 6.7                        | 15                | 85                | 28              | 111            | 1 16          | 2.67                | 1.57  | 53.6                | 57.4  | 62.5  |
|                | White Dent.           |                            |                   |                   |                 |                |               |                     |       |                     |       |       |
| 66             | Boss                  | 6.                         |                   | 80                | 36              | 113            |               |                     |       |                     |       | 56.3  |
|                | Yellow Flint.         |                            |                   |                   |                 |                |               |                     |       |                     |       |       |
| 26             | Minnesota Flint       | 5.3                        | 22                | 81                | 24              | 104            | 1.16          | 3.56                | 1.23  | 33.4                | 45.2  | 53.3  |
| 57             | Dower                 | 5.                         |                   | 83                | 12              | 113            | 1.            |                     | 1.23  | 34.0                |       | 49.7  |
|                | White Flint.          |                            |                   |                   |                 |                |               |                     |       |                     |       |       |
| 52             | Pillsbury             | 5.                         |                   | 90                | 30              | 113            | 1.88          |                     | 2.81  | 34.8                |       | 52.7  |
| 65             | Smut Nose             | 5.5                        |                   | 88                | 24              | 104            |               |                     | 1.74  | 29.6                |       | 60.4  |
|                | Squaw or Mixed Flint. |                            |                   |                   |                 |                |               |                     |       |                     |       |       |
| 32             | Squaw Corn            | 4.3                        | 31                | 81                | 24              | 99             | .97           | 1.81                | .95   | 31.2                | 38.   | 51.3  |
| 41             | Marshall Co. F.       | 3.                         | 20                | 80                | 9               | 88             | .57           |                     | .76   | 14.5                |       | 41.3  |
|                | Sweet Corn.           |                            |                   |                   |                 |                |               |                     |       |                     |       |       |
| 37             | Cosgrove's Sweet      | 6.                         | 35                | 85                | 28              | 115            |               | 2.42                | 2.34  |                     | 38.4  | 42.6  |

*Dent Varieties.*—We have now on hand several most excellent dent varieties, some of which we hope to begin to develop and propagate in quantities. These are adapted to grow for grain and stover in the southern one-third of the state, and for fodder with some immature ears in the central and northern thirds of the state. It is at present the writer's opinion that seed of these large yielding, leafy, dent varieties from Southern Minnesota is better to use for fodder corn in the central and northern parts of the state than is the large southern, or the so-called B. & W. corn. It was hoped some of these dent varieties

we now have on hand would prove suitable to grow for ears farther north than St. Cloud. Facts gained from the reports of two varieties Nos. 5 and 13 distributed in 1895 to numerous farmers, show us that some of the larger yielding dent kinds of corn, which we had hoped would be useful well toward the middle of the state, will not ripen there during such a year as the past when the season is unusually moist and cool. On some farms varieties of dent corn, also flint varieties, under the above named conditions, are reported as having ripened earlier and yielded more than the varieties of dent we sent out. Farther south, on the other hand the varieties we sent out ripened and gave large yields, as they did in our University Farm fields. We are no longer propagating No. 5 with a view to disseminate it.

We have 300 bushels of the corn known as "University No. 13," which we are offering for sale at one dollar per bushel, the price we paid to farmers in the neighborhood of University Farm for raising and saving most of the seed. By putting in some from our own fields we are able to sell this corn, which has been improved in yield by our selection, at the price named, one dollar per bushel, including bags. We hope to procure very cheap freight rates, as some of the railroads are interested in aiding the farmers along their lines in getting the improved seeds distributed by the experiment station. We do not recommend this corn for crops of grain much north of a line running west from Minneapolis. On heavy soils in Renville and surrounding counties it did not in all cases ripen the past season. We are very anxious to get varieties of dent corn which will ripen in a hundred days and which will endure cold conditions better than do most dent kinds. We hope to extend the belt of dent corn north through the middle one-third of the state, especially for all lighter, warm soils. Persons who have corn which they think might prove valuable if distributed, or good stocks from which to breed better varieties are earnestly requested to correspond with us that we may secure a start in the seed.

*Flint Varieties* do not require as warm conditions to retain a healthy green color as the dent varieties. In a field of heavy cold land in 1892 on the North Dakota Agricultural College Farm at Fargo, the writer had growing side by side numerous

varieties of flint and dent corn. The early part of the summer was moist and cool, admirable wheat weather. The dent varieties grew very slowly and had a yellow unhealthy color, while the flint varieties grew more rapidly and had a much darker, healthier green color. During 1895 the two varieties of dent corn we sent out to determine the northern latitude to which they are adapted did not do well in some localities where flint varieties are reported to have made good yields of ripe grain. We may yet find some farmer who has gotten hold of a dent corn well adapted to the colder climatic conditions of our northern districts, and we very much wish to do so, but at present we have more hopes of finding stocks of flint corn which may be developed into standard varieties for those districts. It must be clearly borne in mind that there is not a very great difference in the feeding quality of either the grain or the fodder of the different varieties of corn and that in hunting for varieties to be disseminate we must look mainly for large yielders. Some have an undue prejudice against flint corn because of the hardness of the kernels. Animals have rarely made this objection. There is but slight difference between flint and dent corn by chemical analysis. In the southern one-third of the state doubtless the dent varieties will be used almost exclusively, while in the north one-third the small, early flints will be depended upon. In the central one-third of the state the two will be used, the larger kinds of flint doubtless predominating over the smaller varieties of dents.

*Sweet Varieties* are much sought by dairymen who desire corn fodder grown thickly for their cows. Some of the best crops we have seen were produced by growing thickly the common Minnesota Dent corns, sowing them as close as would be done in the case of sweet or southern fodder corn. These dent varieties grown in this way seem to do quite as well as sweet varieties, and do not grow so coarse and rank as the large southern varieties. The northern part of the state will need a supply of seed of sweet and dent corn, which, owing to the short seasons, must be procured from farther south. Farmers and seedsmen should raise the seed in the southern counties to supply the market for seed for fodder varieties in the northern part of the state. To do this the growers must get up a reputation for certain varieties so that the persons wanting seed to

plant for fodder will know where to order varieties with which they are acquainted. The variety furnished us by Cosgrove Brothers of LeSueur seems to be a very good fodder sort for northern counties as well as a good kind to grow for ears in the southern part of the state. If any one else has a good variety of sweet corn suitable for growing for fodder, they would do us a great favor by writing to the station concerning it that we might procure a start in the seed.

#### DO FARMERS HAVE GOOD YIELDING VARIETIES OF CORN.

For some years we have been testing varieties of corn with a view to procuring the best kinds to be had in the state. We have several varieties which seem to have yielded better than the majority of those tried. In the spring of 1895 we selected two of these best varieties as standards of comparison. Beside them we planted six varieties or samples of dent corn procured from stores in Willmar which had been brought there and offered for sale to their neighbors by the farmers of Kandiyohi County. The presumption is that these varieties had been grown in the county for some years and were counted successful. Mr. T. A. Hoverstad drove around among the farmers in the neighborhood of Coteau Farm, Lyon County, and from each of seven procured a sample of their dent corn, not selecting that which was thought to be the best, but simply choosing a sample of each farmer's seed corn as he came to the successive farmers. In like manner Mr. Andrew Boss collected five varieties of dent corn from farmers in the neighborhood of University Farm in Ramsey County. He also procured four dent varieties in Wabasha County from farmers who have taken especial care to procure the best seed to be found in their vicinity.

By referring to Table LXI it will be observed that the varieties of corn received from Ramsey and Wabasha Counties yielded several bushels per acre more than varieties secured from Kandiyohi and Lyon County farmers. By reference to Table LX it will be seen that the yields of our best dent varieties selected from all sources considerably exceed the Lyon county and the Kandiyohi county varieties, in yield and even averaged three bushels more per acre than the varieties chosen



TABLE LXI.—Corn, Variety Tests.

| University number.                           | NAMES OF FARMERS.          | Height of stalks<br>feet. | Per cent.,<br>stover. | Per cent.,<br>blades. | Height of ears,<br>Inches. | Days<br>maturing. | Yield of Stover |                           |          | Yield of Grain. |                           |          |
|--|----------------------------|---------------------------|-----------------------|-----------------------|----------------------------|-------------------|-----------------|---------------------------|----------|-----------------|---------------------------|----------|
|  |                            |                           |                       |                       |                            |                   | Coteau, 1895.   | University<br>Farm, 1895. | Average. | Coteau, 1895.   | University<br>Farm, 1895. | Average. |
|  |                            |                           |                       |                       |                            |                   |                 |                           |          |                 |                           |          |
| SEED RECEIVED FROM KANDIYOHI COUNTY FARMERS. |                            |                           |                       |                       |                            |                   |                 |                           |          |                 |                           |          |
| 39   | Jens Larson, Willmar.....  | 6.0                       | 80                    | 30                    | 104                        | .77               | .77             | .77                       | 27.3     | 47.2            | 37.2                      |          |
| 40   | L. Moline, Svea.....       | 6.0                       | 80                    | 36                    | 107                        | .92               | 1.23            | 1.07                      | 35.7     | 54.4            | 45.1                      |          |
| 41   | Kieland Bros., Willmar...  | 6.5                       | 20                    | 80                    | 24                         | 104               | .44             | 1.10                      | .77      | 35.2            | 55.4                      | 45.3     |
| 42   | Jos. Feig, Atwater.....    | 6.0                       | 10                    | 81                    | 24                         | 105               | .53             | 1.19                      | .86      | 26.5            | 44.6                      | 35.6     |
| 43   | A. H. Spring, Willmar..... | 6.0                       | 82                    | 30                    | 167                        | .....             | .93             | .....                     | .....    | 55.7            | .....                     | .....    |
| 44   | T. H. Kahlmeyer, Atwater   | 6.5                       | 82                    | 30                    | 109                        | .65               | 1.50            | 1.07                      | 34.9     | 26.6            | 30.7                      |          |
| SEED RECEIVED FROM LYON COUNTY FARMERS.      |                            |                           |                       |                       |                            |                   |                 |                           |          |                 |                           |          |
| 58   | H. Opdahl, Ghent.....      | 5.3                       | 82                    | 30                    | 107                        | .....             | .....           | .....                     | 30.8     | 56.4            | 43.3                      |          |
| 59   | J. G. Rejnier, Ghent.....  | 5.5                       | 19                    | 80                    | 39                         | 111               | .....           | 1.38                      | .....    | 37.5            | 48.8                      | 43.1     |
| 60   | Milton Keil, Lynd.....     | 5.5                       | 10                    | 81                    | 36                         | 110               | .....           | .....                     | .....    | 20.6            | 44.0                      | 32.3     |
| 61   | Milton Keil, Lynd.....     | 5.0                       | 20                    | 79                    | 30                         | 111               | .....           | 1.38                      | .....    | 32.8            | 30.6                      | 31.7     |
| 62   | Milton Keil, Lynd.....     | 6.0                       | 10                    | 79                    | 30                         | 108               | .....           | .....                     | .....    | 40.8            | 47.6                      | 43.9     |
| 63   | J. G. Rejnier.....         | 5.5                       | 15                    | 80                    | 36                         | 115               | .....           | 1.78                      | .....    | 42.2            | 56.6                      | 46.4     |
| 64   | John Wonderlich.....       | 6.0                       | 10                    | 80                    | 42                         | 107               | .....           | .....                     | .....    | 45.7            | 53.6                      | 49.7     |
| SEED RECEIVED FROM RAMSEY COUNTY FARMERS.    |                            |                           |                       |                       |                            |                   |                 |                           |          |                 |                           |          |
| 70   | P. Wiltzbacher, Rosetown.  | 7.0                       | 85                    | 36                    | 105                        | .....             | 1.26            | .....                     | .....    | 50.2            | .....                     | .....    |
| 72   | Frank Wiltzbacher, "       | 6.7                       | 85                    | 30                    | 105                        | .....             | .....           | .....                     | .....    | 60.2            | .....                     | .....    |
| 73   | Wm. Richter, Rosetown...   | 7.0                       | 20                    | 85                    | 36                         | 110               | .....           | 1.38                      | .....    | 50.6            | .....                     | .....    |
| 74   | Frank Gibbs, St. Anth. Pk. | 6.5                       | 83                    | 33                    | 106                        | .....             | .....           | .....                     | .....    | 58.7            | .....                     | .....    |
| 75   | A. Giessmann, Rosetown...  | 6.5                       | 15                    | 81                    | 30                         | 106               | .....           | 1.19                      | .....    | 53.6            | .....                     | .....    |
| SEED RECEIVED FROM WABASHA COUNTY FARMERS.   |                            |                           |                       |                       |                            |                   |                 |                           |          |                 |                           |          |
| 66   | A. Boss.....               | 6.0                       | 80                    | 36                    | 113                        | .....             | .....           | .....                     | .....    | 56.3            | .....                     | .....    |
| 67   | A. Boss.....               | 6.5                       | 25                    | 85                    | 30                         | 108               | .....           | 1.27                      | .....    | 51.0            | .....                     | .....    |
| 68   | A. Boss.....               | 6.5                       | 85                    | 36                    | 117                        | .....             | 1.26            | .....                     | .....    | 52.6            | .....                     | .....    |
| 69   | F. C. Lamont.....          | 6.5                       | 10                    | 86                    | 36                         | 106               | .....           | 1.51                      | .....    | 67.4            | .....                     | .....    |
|  | University No. 13.....     | 6.6                       | 10                    | 79                    | 27                         | 107               | 1.53            | 1.38                      | .....    | 44.5            | .....                     | .....    |
|  | University No. 5.....      | 6                         | 12                    | 82                    | 32                         | 104               | .....           | 1.21                      | .....    | 52              | .....                     | .....    |

from Ramsey and Wabasha Counties. It is safe to conclude that we have more than half a dozen varieties of dent corn which if generally planted throughout the counties mentioned would increase the yield of the crop ten or even twenty per cent. It is our purpose to procure and test the best stocks of corn and having found the best yielders improve them by careful breeding and selection and then disseminate them. We cannot hope, neither do we wish, to sell or give away any large quantities of seed. It is not our purpose to go into the seed business for profit to the station. We simply desire to find or make new varieties and to start their distribution. We desire to give our farmers a standard of comparison so that they will be able to judge as to the yield and other qualities of varieties that they will be satisfied with nothing short of

the most profitable. This work of testing, selecting and breeding, is too expensive for individual farmers. We expect to confine our distribution of each variety to its introduction, and then expect growers and seed dealers to handle its general distribution.

#### CO-OPERATIVE TRIALS OF CORN.

There is nothing more apparent in our experiments with testing varieties of corn than the fact that corn in the same latitude varies greatly with the differences in soil and climate. University No. 5 and University No. 13 were distributed free or sold in quantities from one pound to several bushels in the spring of 1895. These varieties have done admirably at University Farm for a number of years, maturing in ample time and yielding large crops of fine corn. But at points west, as Renville County, and a little north they are reported as not ripening and have yielded very meager crops. Each farmer should try several varieties of corn, choosing for his main crop varieties known to succeed in the neighborhood, and when he finds a kind which is an exceptionally good yielder he should propagate it and use it for his crop until further trial in a small way may discover a better variety. The experiment station hopes to be able to disseminate good varieties suited to each locality in the state or to advise persons where to procure them. There is no other crop of which farmers in the north two-thirds of the state know so little regarding suitable varieties to plant or of how to save the seed as they do about corn.

#### IMPROVING VARIETIES OF CORN.

Good varieties should be improved by most careful selection. The plan under practical use by the experiment station is as follows: We procure half a bushel of the new varieties of corn we deem worthy of trial. A pint or quart planted at each experiment farm is sufficient for a test. At the end of one or two years we have tried each in a few places and those few which yield best we select to multiply and improve by breeding. Only occasionally do we attempt experiments in cross pollenizing by hand. We depend upon natural or wind pollenizing and confine our work mainly to selecting. When we have determined which is the best kind to use as a basis for a new variety, we plant

the remainder of the original unmixed sample of seed, usually a peck or more, on a few to several acres of good land well prepared. The seed is planted slightly thicker than it is desired to stand, using the ordinary check row planter. The drag is used to kill the weeds in the hill until the corn is several inches high and the cultivator follows three to five times to loosen the surface soil and to kill weeds. When the corn is several inches high we pull out of each hill all weak plants in order that the mating may take place among vigorous parents only. When the corn begins to tassel we pass by every hill and remove the weak tassels, in other words, emasculate every stalk which does not promise a good vigorous ear. Thus we secure to the entire field only pollen from vigorous stalks, nearly every one of which has the inherited quality of producing a good yield of grain. When we harvest the corn we pick out for seed all the ears which are nearly perfect and from this bulk of seed we pick out enough of the very choicest ears for our "seed corn patch" the next year. Where the fodder is not needed the ears should be husked from the standing stalks that the selection may be made not only from good ears but from good stalks also. Such considerations as having ears on a stem small enough so that the ear will hang down and also be easily broken off in husking is of some importance. It is desirable, likewise, to have no stools as they make cutting and harvesting much more difficult. Since the era of corn harvesters has come we must have stalks easily handled with self-binders. A lot of ears and stools near the ground make a butt heavy bundle and we can much more easily bind corn with no stools and with only one or two ears near the middle of the stalk. Some of our observations indicate that we can select varieties which ripen the ear before the stalk, thus giving us ripe grain and comparatively green fodder.

#### SAVING SEED CORN.

Saving seed corn is more difficult the farther we proceed north. The season for ripening is short, often resulting in the selection of slightly immature seed. Cold weather coming on does not admit of rapid drying and if the cob and grains are not perfectly dry when freezing weather occurs the moist kernels are injured by the frost. Corn to be saved for seed

should be harvested early and then thoroughly dried as rapidly as possible. When the ears can be hung up by the husks in a dry place that plan works well. If the corn can be husked and spread out in a dry place on shelves or on a floor and laid only one ear deep it will dry nicely. Drying in a room artificially heated by a fire is the ideal way to prepare seed corn for preservation through the winter. When thoroughly dry the corn may be piled up a foot or less deep on some dry floor or put in bags and stored in a dry place until spring. Seed corn thoroughly dried as by artificial heat will not absorb moisture from the air, but will remain dry till planted.

If the seed corn is to be saved out of the bulk of corn as it is husked from shocks or standing stalks it should be picked out before being thrown into the crib, unless indeed very dry, as corn in bulk often becomes heated, which weakens or kills the germ. Disaster often follows piling up a large amount of corn from which seed is to be selected. Comparatively little heating in the crib hurts the seed. Likewise, seed corn should never be stored above bins of grain or over rooms occupied by live stock. The moisture, and possibly gases coming from the grain or the stock, weaken or destroy the vitality of the seed. The seed will probably stand a better chance of being preserved if left on the ear until near corn planting time. The great principle in saving seed corn is to dry all the water out of it until it is dry and hard and it will not again easily absorb moisture from the air.

#### TESTING SEED CORN.

Testing seed corn is far too often neglected. Corn which has been thoroughly dried and then properly stored will lay in the ground for a few weeks without rotting should a long, wet, cold season occur. Corn which was not well dried, but was repeatedly frozen when moist and its vitality injured, will very soon rot if the soil is so wet and cold as to retard germination. The person accustomed to testing seed corn can determine whether a given sample comes with strong or weak vitality and whether or not it would lay long in the soil before rotting. A little nice care in drying and preserving seed corn materially increases the chances for a crop of corn.

Corn may be tested in earth in a pan or other vessel in the house. If kept warm and moist, not wet, this method tells what proportion of the kernels will grow under favorable conditions, but does not indicate the amount of unfavorable weather the seed will stand. To test the vitality of the seed the vessel of soil should be kept at such a low temperature that most of the corn will not sprout for nearly ten days. If it will then grow it is not only alive but full of vitality. Other devices may be arranged. A pan, as a pie tin, turned upside down on the bottom of a larger vessel and over this some cloths spread makes a good device. One cloth should first be spread over the upturned pie tin and the seeds be laid on this. The seeds should then be covered with one or more thicknesses of cloth. Both or all of the cloths should hang down to the bottom of the outer vessel which should be filled with water to a point half an inch or more below the seeds. The cloth acting as a lamp wick, keeps the seeds moist.

#### CORN, DEPTH TO PLOW AND SUBSOILING FOR.

In 1895 at University Farm, Series III, Field H, eight rods by thirty and one-half rods, was divided into eight plots running lengthwise and the plots were plowed at different depths and some were subsoiled. Table LXII gives the results of each plot and the averages of plots receiving similar treatment. The land bore a crop of wheat and varieties of barley in 1894 and was in fairly good heart. University No. 13 corn was the variety used and a very good crop of ears was husked out. The land was spring plowed, well pulverized and the corn was planted on May 24th. The corn was cut and shocked Sept. 12th, and when husked November 10th, 75 pounds of ear corn were reckoned for each bushel.

The land plowed four inches deep produced slightly more corn than that plowed six inches deep and several bushels more per acre than that plowed eight inches deep and subsoiled six inches deeper. This is, of course, too limited a trial to give much weight. Besides we had an unusually favorable season as to the amount of rainfall, and especially as to its distribution throughout the growing months. The season was also cooler than usual and this may have been unfavorable to the subsoil-

ing. General facts and experiences acquired by the writer make him doubt the economy of subsoiling any unless it be our heaviest Minnesota soils, as the expense is considerable and the results not certain. Much experimenting along this line has been planned and in a few years we hope to be able to speak more authoritatively as to which soils and for what crops it will pay to subsoil. Doubtless for root crops and for young trees on heavy lands subsoiling will be generally profitable, if anywhere, in the northwest and on light soils unprofitable.

TABLE LXII.—CORN.—Depth to Plow and Subsoiling for Corn.

| Plot No. | Depth Plowed  | Subsoiled.       | Yield per Acre. |       |
|----------|---------------|------------------|-----------------|-------|
|          |               |                  | Stover.         | Corn. |
| 1        | 8 inches..... | 6 in. deeper.... | 1.46            | 61.2  |
| 2        | 6 ".....      | None.....        | 1.37            | 57.5  |
| 3        | 6 ".....      | ".....           | 1.63            | 66.4  |
| 4        | 4 ".....      | ".....           | 1.50            | 63.3  |
| 5        | 4 ".....      | ".....           | 1.53            | 68.2  |
| 6        | 6 ".....      | ".....           | 1.53            | 70.4  |
| 7        | 6 ".....      | ".....           | 1.37            | 63.3  |
| 8        | 8 ".....      | 6 in. deeper.... | 1.72            | 57.8  |
| 4&5      | 8 ".....      | ".....           | 1.59            | 59.5  |
| 3&6      | 6 1/2 ".....  | None.....        | 1.50            | 64.4  |
| 2&7      | 6 1/2 ".....  | ".....           |                 |       |
| 1&8      | 4 ".....      | 6 in. deeper.... | 1.51            | 65.8  |

## WHEAT, VARIETY TESTS AND IMPROVEMENT OF VARIETIES.

In 1895 the testing of varieties of wheats, discussed in Bulletin No. 40, pages 254 to 270, was continued with added interest and success. Out of about 250 collected varieties kept under trial since 1889, twenty-two having the highest yield, were retained and again planted at University Farm and at Coteau Farm. These varieties are shown in Bulletin No. 40 in a separate table on page 260 and in this Bulletin in Table LXIII.

TABLE LXIII.—WHEAT.—Twenty-two Best of 250, 1889, Collected Varieties.

| University No. | VARIETY.               | Height. | Length of head. | Bearded or smooth. | Color of chaff. | Chaff, velveted or smooth. | Chaff holds.  | Days maturing. | Weight per bushel, 1895. |              | Grade. | Yield, 1893. | Grade. | Coteau yield, 1894. | Grade. | Coteau yield, 1895. | Grade. | Yield at Univ., 1895. | Grade. | Average of five yields. | Average of five grades. |
|----------------|------------------------|---------|-----------------|--------------------|-----------------|----------------------------|---------------|----------------|--------------------------|--------------|--------|--------------|--------|---------------------|--------|---------------------|--------|-----------------------|--------|-------------------------|-------------------------|
|                |                        |         |                 |                    |                 |                            |               |                | Weight per bushel, 1895. | Yield, 1892. |        |              |        |                     |        |                     |        |                       |        |                         |                         |
| 9              | Snowball               | 37      | 3.2             | S                  | W.              | S                          | Poor.         | 100            | 57                       | 33.3         | 2N     | 13.7         | 1N     | 21.5                | 1N     | 13.5                | 3N     | 28.7                  | 3N     | 22.1                    | 1N                      |
| 13             | Blount's Hybrid No. 15 | 34      | 3.2             | S                  | W.              | S                          | Med. to good. | 102            | 59                       | 17.3         | 3N     | 12.8         | 1N     | 23.8                | 1N     | 23.5                | 1H     | 32.9                  | 1N     | 21.3                    | 1N                      |
| 19             | White Russian          | 35      | 3.8             | S                  | W.              | S                          | Good.         | 100            | 57                       | 17.7         | 2N     | 11.9         | 1N     | 23.                 | 1N     | 21.5                | 3N     | 33.2                  | 3N     | 21.4                    | 1N                      |
| 23             | Pringle's Champlain    | 35      | 3.1             | B                  | W.              | S                          | Good.         | 100            | 55                       | 16.          | 2N     | 11.9         | 2N     | 24.2                | 1H     | 10.                 | 1N     | 31.7                  | 1N     | 19.8                    | 1N                      |
| 27             | Assiniboine Bearded    | 36      | 2.5             | B                  | R.              | S                          | Medium.       | ...            | ...                      | 14.7         | 2N     | 12.6         | 2N     | 23.9                | 1H     | 20.7                | 3N     | ...                   | ...    | 18.                     | 2N                      |
| 51             | Haynes' Blue Stem      | 32      | 3.2             | S                  | Blue & W.       | V                          | Medium.       | 102            | 58                       | 16.6         | 1H     | ...          | ...    | 20.6                | 3N     | 24.7                | 1H     | ...                   | 1N     | 20.9                    | 2N                      |
| 66             | Powers' Fife           | 33      | 2.6             | S                  | W.              | S                          | Med. to good. | ...            | 59                       | 21.3         | 1N     | 15.1         | 1H     | 19.8                | 1H     | 22.8                | 1H     | 26.3                  | 1N     | 21.1                    | 1H                      |
| 71             | White Fife             | 36      | 3.1             | S                  | W.              | S                          | Medium.       | 101            | 59                       | 19.          | 1H     | 11.9         | 1N     | 19.8                | 1N     | 20.3                | 1N     | 25.5                  | 3N     | 20.1                    | 1H                      |
| 72             | Rio Grande             | 35      | 3.6             | B                  | W.              | S                          | Good.         | 101            | 60                       | 22.6         | 2N     | 11.2         | 1N     | 21.                 | ...    | 20.7                | 3N     | 29.3                  | 1H     | 20.9                    | 1N                      |
| 74             | Glyndon                | 34      | 3.1             | S                  | W.              | S                          | Med. to good. | 101            | 60                       | 15.2         | 1N     | 11.8         | 1N     | 20.3                | 1H     | 18.8                | 3N     | 31.7                  | 1H     | 19.7                    | 1N                      |
| 76             | " 638                  | 35      | 2.6             | S                  | W.              | S                          | Med. to good. | 101            | 60                       | 13.7         | 1N     | 13.8         | 1H     | 18.1                | 1N     | 15.4                | Rej    | 29.7                  | 1H     | 20.2                    | 1N                      |
| 95             | " 675                  | 37      | 2.5             | S                  | W.              | S                          | Medium.       | 101            | 60                       | 16.3         | 2N     | 9.9          | 1N     | 14.9                | 1N     | 19.                 | 1N     | 32.5                  | 1H     | 16.5                    | 1N                      |
| 96             | " 675 (28 at G, 1891)  | 35      | 2.8             | S                  | W.              | S                          | Medium.       | 101            | 59                       | 15.          | 2N     | 12.          | 1H     | 18.3                | 1N     | 23.3                | 2N     | 29.8                  | 1H     | 19.7                    | 1N                      |
| 99             | " 687                  | 37      | 2.7             | S                  | W.              | S                          | Good.         | 101            | 60                       | 15.3         | 1N     | 11.7         | 1N     | 19.9                | 1N     | ...                 | ...    | 35.1                  | 1H     | 20.5                    | 1N                      |
| 100            | " 691                  | 36      | 2.8             | S                  | W.              | S                          | Good.         | 101            | 61                       | 17.7         | 2N     | 10.2         | 3N     | 23.                 | 1N     | 7.7                 | 1H     | 31.3                  | 1H     | 18.                     | 1N                      |
| 104            | " 697                  | 38      | 2.7             | S                  | White & brown   | S                          | Med. to good. | 100            | 59                       | 14.3         | 2N     | 9.1          | Rej    | 19.8                | 2N     | 16.1                | ...    | 28.7                  | 2N     | 17.6                    | 2N                      |
| 105            | " 711                  | 35      | 3.              | S                  | W.              | S                          | Med. to good. | 101            | 61                       | 23.3         | 2N     | 10.          | 1N     | 21.4                | 1N     | 22.8                | 1H     | 31.8                  | 1H     | 21.9                    | 1N                      |
| 112            | " 750                  | 36      | 3.              | S                  | W.              | S                          | Med. to good. | 102            | 60                       | 16.          | 3N     | 14.6         | 1N     | 24.2                | 1N     | 23.2                | Rej    | 31.                   | 3N     | 21.8                    | 2N                      |
| 113            | " 754                  | 40      | 3.              | S                  | W.              | S                          | Med. to good. | 103            | 59                       | 17.7         | 1N     | 11.5         | 1N     | 20.                 | ...    | ...                 | ...    | 31.2                  | 3N     | 20.1                    | 2N                      |
| 116            | " 758                  | 38      | 2.8             | S                  | W.              | S                          | Medium.       | 102            | 60                       | 14.7         | 2N     | 14.3         | 1N     | 19.3                | 1N     | 20.6                | ...    | 31.                   | 1N     | 20.1                    | 1N                      |
| 125            | " 815                  | 38      | 2.8             | S                  | White & brown   | S                          | Good.         | 102            | 60                       | 15.          | 1N     | 14.5         | 1H     | 22.2                | 1N     | 25.6                | ...    | 33.3                  | 1N     | 19.1                    | 1N                      |
| 146            | Bolton's Blue Stem     | 38      | 2.7             | S                  | W.              | V                          | Good.         | 102            | 59                       | ...          | ...    | 17.8         | ...    | 21.4                | ...    | 20.                 | 1H     | 35.3                  | 1H     | 23.6                    | 1N                      |

This last table gives most of the facts obtained in five to eight trials of these twenty-two varieties of wheat. The yields given in column 21 are the averages of five yields. Some of the varieties were tested one, two or three times more but only the five were used so as to make the averages comparable. The average grades, column 22, likewise were made up from the grades of five tests. The firmness with which the chaff prevents shelling in the field, column 8, the number of days required to mature a crop, column 9, and the weight per bushel, column 10 are averages of the results of two tests. The eight varieties given in Table LXIV are the ones chosen for further propagation and distribution by the experiment station. These varieties are our best yielders and are all nearly or quite equal in quality to the best hard wheats we have. It is not our purpose to carry out any plan of free distribution of these varieties, but rather to produce each year one or possibly more, of our best tried or improved varieties, in such quantity that we may distribute in every part of the state enough wheat to seed a few acres. To give outright to the farmers this amount of wheat would be impossible without a very large fund of money. By charging a little more than market price we can thus grow and distribute quite large quantities. The farmers will be required to pay, besides the actual market value of the wheat, only a small amount for the superior quality of the grain, simply enough to pay for the extra trouble in cleaning, handling and for bags and nothing for the cost of breeding and testing for which the funds of the experiment station may properly be used. On lands belonging to the University we can hope to produce only a hundred bushels, or less, of each variety we design to distribute. To increase this to one or a few thousand bushels, so as to give it at once a wider distribution it will be necessary to furnish the seed to some careful farmer who will raise the grain on land free of weeds and clean, bag and ship under our orders to those to whom we sell it; or we may take the grain in bulk from the farmer and clean and bag it in our own buildings.

University No. 105 (Glyndon 711) came to us in 1889 from Thos. P. Heenan, Consul at Odessa, Russia, and was labelled Polish Winter Wheat. It is a spring wheat and doubtless a mistake has been made in the name. Its general appearance



is very similar indeed to Red Fife. This wheat seems to be the best new variety we have to distribute, though little if any better in yield or quality than our best varieties of Red Fife and spring Blue Stem. We have on hand 38 bushels of this wheat which we design sowing on Northwest Sub-Experiment Farm at Crookston in 1896 with a view to obtaining several hundred bushels to disseminate throughout the state, providing milling and baking tests prove it worthy of trial by the farmers of the state.

TABLE LXIV.—Wheat, 8 Best Out of 250 Collected Varieties.

| University Number. | VARIETY.                | Height. | Length of head. | Bearded or smooth. | Color of chaff. | Chaff velveted or smooth. | Chaff holds. | Days maturing. | Weight per bu., 1895. | Yield, 1892. | Grade. | Yield, 1893. | Grade. | Coteau yield, 1894. | Grade. | Coteau yield, 1895. | Grade. | Yield at University, 1895. | Grade. | Average of five yields. | Average of five grades. |
|--------------------|-------------------------|---------|-----------------|--------------------|-----------------|---------------------------|--------------|----------------|-----------------------|--------------|--------|--------------|--------|---------------------|--------|---------------------|--------|----------------------------|--------|-------------------------|-------------------------|
| 13                 | Blount's Hybrid No. 15. | 34      | 3 2             | S.                 | W.              | S.                        | M. to G.     | 102            | 59                    | 17.33        | N      | 12.8         | N      | 23.8                | N      | 23.5                | H      | 29.0                       | N      | 21.3                    | N                       |
| 19                 | White Russian.          | 38      | 3 8             | S.                 | W.              | S.                        | Good         | 100            | 57                    | 17.72        | N      | 11.9         | N      | 23.0                | N      | 21.5                | N      | 33.2                       | N      | 21.4                    | N                       |
| 51                 | Haynes' Blue Stem.      | 38      | 3 2             | S.                 | B. & W.         | V.                        | Med.         | 102            | 58                    | 16.6         | H      | .....        | .....  | 20.6                | N      | 24.7                | H      | 21.6                       | N      | 20.9                    | N                       |
| 66                 | Powers' Fife.           | 33      | 2 6             | S.                 | W.              | S.                        | M. to G.     | .....          | 59                    | 21.3         | N      | 15.1         | H      | 19.8                | H      | 22.8                | H      | 26.3                       | N      | 21.1                    | H                       |
| 72                 | Rio Grande.             | 35      | 3 6             | B.                 | W.              | S.                        | Good         | 101            | 60                    | 22.62        | N      | 11.2         | N      | 21.0                | .....  | 20.7                | N      | 29.3                       | H      | 20.9                    | N                       |
| 105                | Glyndon 711.            | 35      | 3 0             | S.                 | W.              | S.                        | M. to G.     | 101            | 61                    | 23.32        | N      | 10 0         | N      | 21.4                | N      | 22.8                | H      | 31.8                       | H      | 21.9                    | N                       |
| 116                | Glyndon 758.            | 38      | 2 8             | S.                 | W.              | S.                        | Med.         | 102            | 60                    | 14.72        | N      | 14.3         | N      | 19.3                | N      | 20.6                | N      | 31.5                       | N      | 20.1                    | N                       |
| 146                | Bolton's Blue Stem.     | 38      | 2 7             | S.                 | W.              | V.                        | Good         | 102            | 59                    | .....        | .....  | 17.8         | .....  | 21.4                | .....  | 20.0                | H      | 35.3                       | H      | 23.6                    | N*                      |

\* As we have grades of No. 146 for only two years, we deemed it hardly fair to put it in as 1 H wheat.

Some of the other eight kinds of wheat shown in Table LXIV may be chosen in future years for distribution, or if some of the varieties originated in 1892 by selection, (See Table LXV) or later by selection or by crossing, or other superior varieties collected from outside sources, prove better than these standard sorts, they may take precedence in our distribution. We can reasonably hope to disseminate one or even more superior varieties of wheat each year if present indications hold out as to the results of the breeding in our Field Crop Nursery, or in other words, other varieties of wheat will be substituted for distribution as soon as proved superior.

#### SELECTED OR PURE BRED VARIETIES OF 1892.

In Table LXV are given the yields of thirty-five varieties of wheat originated in 1892. These wheats are mentioned on pages 262 to 264 in Bulletin No. 40 of this station. They were originated by selecting the ten best out of the four hundred plants of each of the respective varieties, grown a foot apart each way, and upon weighing these ten plants, the heavy yielding ones were chosen. Thirty-five mother plants thus chosen were preserved as the basis of as many varieties of wheat. In 1893 several hundred grains of each of these thirty-five stocks of grain were planted the seeds being again planted a foot apart each way. About one-fourth of the poorer plants were discarded and upon threshing out the remainder about a quart of seed was secured. In 1894 this seed was planted in small plots, using the ordinary drill, making the plots only two feet wide with foot-wide alleys between. Several quarts of seed having resulted from each we were able to plant one-twentieth of an acre of each kind of these wheats in 1895. In order to compare these wheats, each newly originated from a single plant, with the parental kinds from which a number of them were selected, Power's Fife, (University No. 51), and Haynes' Blue Stem, (University No. 66), are given in the upper two lines of Table LXV. The yields of the eight new varieties which sprung from Haynes' Blue Stem and seven kinds which sprung from Power's Fife are collected in groups in the table. The average yield of the eight Haynes' Blue Stem progeny is 31.9 bushels per acre, while the parent sample yielded only 21.6 bushels. an average increase in yield of over ten bushels per acre. The heaviest

yielding new varieties produced an increase of over sixteen bushels over the original seed. The average yields of the seven Power's Fife progeny was 35.4 bushels, while the original sample produced 26.3 bushels per acre, an average increase of 9.1 bushels per acre. It is of interest that while the increase of grain is very large that there is no material increase in the yield of straw. (See the right hand column in Table LXV.)

TABLE LXV.—WHEATS.—Original Seed vs. Seed Improved by Selection.

| University No.                                   | VARIETY.             | days Maturing | Height. | Length of head. | Bearded or smooth. | Color of chaff. | Chaff vely. or smooth. | Chaff holds. | Grade. | Weight per bus. | Grain per acre. | Straw per acre. | Average yield. |        |
|--|----------------------|---------------|---------|-----------------|--------------------|-----------------|------------------------|--------------|--------|-----------------|-----------------|-----------------|----------------|--------|
|  |                      |               |         |                 |                    |                 |                        |              |        |                 |                 |                 | Straw.         | Grain. |
| 51   | Hayne's Blue Stem..  | 110           | 37      | 3               | S                  | Blue.           | V                      | Good         | 1 N    | 1.7             | 21.6            | 58              | 1.7            | 21.6   |
| 66   | Power's Fife.....    | 110           | 36      | 2½              | S                  | W               | S                      | Med.         | 1 N    | 2.2             | 26.3            | 59              | 2.2            | 26.3   |
| New Varieties Originated by Selection in 1892.   |                      |               |         |                 |                    |                 |                        |              |        |                 |                 |                 |                |        |
| 159  | Haynes' Blue Stem..  | 111           | 43      | 2¾              | S                  | Blue.           | V                      | Good         | 1 H    | 1.6             | 20.3            | 57              | .....          | .....  |
| 161  | " "                  | 111           | 44      | 3½              | S                  | W & B           | V                      | Poor.        | 1 H    | 1.4             | 27.2            | 58              | .....          | .....  |
| 169  | " "                  | 108           | 44      | 3¼              | S                  | Bluish          | V                      | Good         | 1 H    | 2.4             | 37.8            | 58              | .....          | .....  |
| 170  | " "                  | 108           | 43      | 4¼              | S                  | "               | V                      | Good         | 1 N    | 2.5             | 37.9            | 58              | .....          | .....  |
| 173  | " "                  | 108           | 38      | 4               | S                  | "               | V                      | Good         | 1 N    | 2.1             | 34.7            | 56              | .....          | .....  |
| 175  | " "                  | 108           | 43      | 3¼              | S                  | Brown           | V                      | Good         | 1 N    | 1.9             | 32.5            | 57              | .....          | .....  |
| 179  | " "                  | 108           | 41      | 2¾              | S                  | Blue            | V                      | Good         | 1 N    | 1.9             | 27.2            | 56              | .....          | .....  |
| 180  | " "                  | 109           | 42      | 2¾              | S                  | Blue.           | V                      | Good         | 1 N    | 1.9             | 28.8            | 57              | 1.9            | 31.9   |
| 147  | Power's Fife.....    | 111           | 45      | 2¾              | S                  | W               | S                      | Good         | 1 H    | 2.5             | 35.7            | 61              | .....          | .....  |
| 148  | " "                  | 111           | 43      | 3               | S                  | Fair.           | H                      | 2.4          | 35.    | 62              | .....           | .....           |                |        |
| 149  | " "                  | 111           | 40      | 3               | S                  | W               | S                      | Good         | 1 H    | 1.4             | 36.2            | 62              | .....          | .....  |
| 150  | " "                  | 111           | 43      | 2½              | S                  | W               | S                      | Good         | 1 H    | 1.3             | 37.7            | 61              | .....          | .....  |
| 151  | " "                  | 111           | 42      | 3               | S                  | W               | S                      | Fair.        | 1 H    | 2.2             | 32.6            | 60              | .....          | .....  |
| 152  | " "                  | 111           | 41      | 3¼              | S                  | W               | S                      | Good         | 1 H    | 2.6             | 34.3            | 60              | .....          | .....  |
| 166  | " "                  | 108           | 38      | 3½              | S                  | W               | S                      | Fair.        | 1 H    | 2.2             | 36.7            | 60              | 2.1            | 35.43  |
| 153  | Glyndon 818.....     | 111           | 38      | 2¾              | S                  | W               | S                      | Med.         | 1 N    | 2.2             | 33.2            | 59              | .....          | .....  |
| 154  | " "                  | 111           | 40      | 3               | S                  | W               | S                      | Good         | 1 H    | 2.3             | 30.3            | 59              | .....          | .....  |
| 155  | " "                  | 111           | 43      | 3               | S                  | W               | S                      | Fair.        | 1 H    | 2.3             | 32.3            | 61              | .....          | .....  |
| 156  | " "                  | 111           | 41      | 2¾              | S                  | W               | S                      | Fair.        | 1 N    | 2.1             | 30.2            | 60              | 2.2            | 31.5   |
| 157  | " 753.....           | 111           | 45      | 2¾              | S                  | W               | S                      | Good         | 3 N    | 2.              | 30.9            | 66              | .....          | .....  |
| 158  | " "                  | 111           | 41      | 2¾              | S                  | W               | S                      | Fair.        | 3 N    | 2.1             | 31.9            | 60              | .....          | .....  |
| 182  | " "                  | 111           | 40      | 3½              | S                  | W & B.          | V                      | Poor.        | 1 H    | 1.4             | 27.2            | 59              | 1.8            | 30.    |
| 163  | " 811.....           | 109           | 40      | 4               | S                  | W               | S                      | Fair.        | 1 N    | 2.8             | 42.7            | 60              | .....          | .....  |
| 168  | " "                  | 108           | 42      | 3¼              | S                  | W               | S                      | Good         | 3 N    | 2.9             | 42.2            | 60              | .....          | .....  |
| 174  | " "                  | 108           | 41      | 3½              | S                  | W               | V                      | Good         | 1 H    | 1.8             | 33.2            | 57              | 2.4            | 30.4   |
| 197  | " 761.....           | 108           | 41      | 3               | S                  | W               | S                      | Good         | 3 N    | 2.1             | 35.             | 60              | .....          | .....  |
| 176  | " "                  | 108           | 37      | 2¾              | S                  | W               | S                      | Fair         | 3 N    | 2.              | 29.2            | 59              | .....          | .....  |
| 178  | " "                  | 108           | .....   | .....           | S                  | .....           | S                      | .....        | 1 H    | 2.1             | 30.             | 57              | 2.1            | 31.4   |
| 164  | Wellman's Fife.....  | 102           | 38      | 3¼              | S                  | W               | S                      | Good         | 1 H    | 2.6             | 37.3            | 58              | .....          | .....  |
| 165  | " "                  | 108           | 45      | 3               | S                  | W               | S                      | Good         | 1 N    | 2.6             | 39.3            | 58              | .....          | .....  |
| 172  | " "                  | 108           | 45      | 3¼              | S                  | W               | S                      | Good         | 1 N    | 2.3             | 33.3            | 57              | 2.5            | 36.6   |
| 160  | Hauan.....           | 111           | 40      | 3               | S                  | W               | S                      | Fair.        | 1 N    | 1.6             | 30.7            | 59              | .....          | .....  |
| 170  | " "                  | 108           | 42      | 3               | S                  | W               | S                      | Good         | 1 H    | 2.3             | 35.             | 59              | 1.9            | 32.8   |
| 181  | McKendry's Fife..... | 108           | 38      | 3¼              | S                  | W               | S                      | Good         | 1 H    | 2.3             | 34.5            | 59              | 2.3            | 34.5   |
| 162  | Glyndon 758.....     | 109           | 38      | 3½              | S                  | W               | S                      | Fair.        | 3 N    | 1.8             | 33.8            | 60              | 1.8            | 33.8   |
| 183  | Lost Nation.....     | 108           | 42      | 3               | S                  | W               | S                      | Good         | 1 N    | 1.8             | 32.8            | 57              | 1.8            | 32.8   |
| 184  | North Star.....      | 108           | 46      | 4¼              | S                  | W               | S                      | Good         | 1 N    | 2.2             | 30.             | 58              | 2.2            | 30.    |
| Saunders Cross Bred Varieties Collected in 1895. |                      |               |         |                 |                    |                 |                        |              |        |                 |                 |                 |                |        |
| 185  | Advance.....         | 43            | 2¼      | B               | B                  | S               | S                      | Good         | 1 N    | 2.5             | 45.4            | 58              | .....          | .....  |
| 186  | Crown.....           | 44            | 3       | B               | B                  | S               | S                      | Good         | 2 N    | 1.7             | 36.2            | 56              | .....          | .....  |
| 187  | Stanley.....         | 42            | 3       | S               | B & W              | S               | S                      | Fair.        | 2 N    | 3.              | 37.5            | 57              | .....          | .....  |
| 188  | Preston.....         | .....         | .....   | .....           | .....              | S               | S                      | .....        | 1 H    | 3.              | 44.             | 58              | .....          | .....  |
| 189  | Percy.....           | 39            | 3       | S               | Br.                | S               | S                      | Good         | 1 N    | 1.9             | 29.7            | 57              | 2.4            | 38.6   |

It will be observed that the varieties originated by selection from several other kinds of wheat also gave large yields generally, though we did not have the parental varieties with which to compare them. The three new kinds originated from (G 811) a wheat supposed to have come from Russia, the name of which was lost by fire, are especially worthy of note, two of them yielding over 42 bushels per acre. While the large yields of these varieties of wheat encourage us, the increase shown this very favorable year is entirely too good to last. And we realize that hopes built upon such results would go the way of many phenomenal results experienced by the breeder of plants. But we feel safe in the hope that a small material increase in the yields of our northwestern hard wheats may result, and that in like manner our work in breeding oats, barley, field peas, timothy, clover and other field crops may cause the thorough husbandman to harvest more from his fields. Some persons fear that the larger yields resulting from these experiments will soon be lost when the varieties are placed under ordinary treatment. Whether this proves true we cannot determine without trial. The mother plants from which each of these varieties sprung were selected because under conditions of an ample food supply they made large yields. The yields in 1895 were obtained on rich soils which had been practically summer fallowed during the very dry year of 1894. When placed on poorer soil it is a question whether they will yield more than the parental varieties and we await with interest their trial under the different conditions of our three or four experiment farms.

#### NEW VARIETIES OF WHEAT COLLECTED IN 1895.

In 1895 several new varieties of wheat were collected from outside sources, and the reports of yields, etc., are shown at the bottom of Table LXV. University No. 184 came to us under the name North Star from Mr. H. Edlund, Fertile, Minn.

#### CROSSED WHEATS.

Numerous crosses made in 1892 and subsequent years are being grown, some of which are very promising. A number of these, See Table LXVI, have been produced in sufficient quantity in our field crop nursery that they will this season for the first time enter our field trials. Numerous other crosses

are being subjected to most rigid selection from year to year so as to reduce them to uniform types and, what is of far greater importance, to gain any advantage possible of their variations toward large yields. Each berry resulting from heads of wheat on which we have cross-pollenized flowers is planted alone, one foot between plants each way, and the weight of shelled grain, "the performance record," is kept. The next year one or more hundred grains are planted from each promising plant of the first generation and one or more of the best yielding plants are saved. From each of these a hundred or more grains are planted and the selection again is limited to one or a few plants, each of which may become the mother plant of a new variety. But the expense of carrying a variety through field tests is so great that only those showing large annual yields of the best individual plants will be chosen, else the varieties will become too numerous. The product of a single plant may be increased to several bushels in four or five years and in six to eight years to more than a thousand bushels. Wheat is very closely fertilized and the single plant thus becomes the double parent of an entire variety. If the selection is made to a single plant for three years it is believed that a variety resulting from a cross will be reasonably true to the type of the mother plant. In some cases we shall continue the selection of crossed stocks to single best producing plants for several years after varieties have been started. In this case varieties started later will simply be from mother plants selected down to the best single plant through a longer series of years. Likewise numerous crosses between crosses, three-fourth crosses and seven-eighths crosses are being made, and numerous theoretical experiments are under way to determine the best manner of breeding wheat. We are using as foundation stocks mainly superior hard wheats, and while we must choose wheats of high quality so as to increase rather than decrease the fame of the northwest for No. 1 hard grades, we keep constantly in mind the fact that the farmer gets more money per acre out of his crop of wheat because of a few bushels more yield per acre even if he suffers a loss of a grade.

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NOTE.—In Table LXVI, are given the notes of yield on twelve varieties of wheats originated by selection to a single parent plant for three years and the fourth year selecting only a fair percentage of the best plants grown in our field crop nursery a foot apart each way. Six cross-bred varieties are also given, these having been selected to a single plant for only one or two years

TABLE LXVI.—Varieties Proposed For University Numbers and Field Trial in 1896.

| University No. | NAME OF FOUNDATION STOCKS. | 1892.            |       | 1893.            |      | 1894.            |      | Average. | 1895.           |                | Total weight grams. | Average Wt. per plants, grams. |
|----------------|----------------------------|------------------|-------|------------------|------|------------------|------|----------|-----------------|----------------|---------------------|--------------------------------|
|                |                            | Crop Nursery No. | Wt.   | Crop Nursery No. | Wt.  | Crop Nursery No. | Wt.  |          | Nursery Century | No. of plants. |                     |                                |
| *276           | P. Fife.....               | 103              | 13.8  | 806              | 11.8 | 2,222            | 6.1  | 10.6     | 23,201          | 25             | 226.7               | 9.0                            |
| *277           | P. Fife.....               | 103              | 13.8  | 883              | 11.  | 2,404            | 5.7  | 10.2     | 23,301          | 25             | 226.7               | 9.0                            |
| *278           | G. 818.....                | 2,475            | 15.0  | 3,018            | 14.3 | 3,130            | 4.9  | 11.4     | 23,601          | 25             | 283.3               | 11.3                           |
| *279           | G. 818.....                | 2,475            | 15.0  | 3,060            | 12.6 | 3,370            | 4.7  | 10.8     | 24,001          | 25             | 283.3               | 11.3                           |
| *280           | G. 753.....                | 1,302            | 11.2  | 4,887            | 15.5 | 4,250            | 5.2  | 10.6     | 24,501          | 25             | 226.7               | 9.0                            |
| *281           | G. 753.....                | 1,325            | 13.8  | 5,374            | 16.7 | 4,760            | 5.7  | 12.1     | 24,801          | 25             | 283.0               | 11.3                           |
| *282           | H. Blue stem.              | 551              | 19.3  | 7,986            | 20.5 | 7,114            | 2.7  | 13.8     | 27,301          | 25             | 311.7               | 12.4                           |
| *283           | H. Blue stem.              | 551              | 19.3  | 7,995            | 17.2 | 7,621            | 7.0  | 14.5     | 27,701          | 25             | 340.0               | 13.6                           |
| +284           | McKendry's F               | 953              | ..... | 6,623            | 6.2  | 173              | 7.3  | .....    | 101             | 200            | 2,805.4             | 14.0                           |
| +285           | G. 761.....                | 173              | ..... | 6,650            | 2.4  | 311              | 4.9  | .....    | 1,601           | 175            | 2,040.3             | 11.6                           |
| +286           | G. 811.....                | 2,174            | ..... | 6,661            | 10.8 | 804              | 9.9  | .....    | 4,301           | 300            | 3,627.2             | 12.0                           |
| +287           | McKissick's F              | 4,791            | ..... | 6,682            | 4.2  | 1,379            | 7.7  | .....    | 7,101           | 200            | 1,926.9             | 9.6                            |
| +288           | McKendry's F               | 884              | ..... | 6,632            | 4.7  | 219              | 5.5  | .....    | 601             | 100            | 1,360.2             | 13.6                           |
|                | McKendry's F               | 982              | ..... |                  |      |                  |      |          |                 |                |                     |                                |
| +289           | H. Blue stem.              | 753              | ..... | 6,652            | 5.1  | 363              | 6.7  | .....    | 2,601           | 100            | 1,360.2             | 13.6                           |
|                | G. 761.....                | 1,899            | ..... |                  |      |                  |      |          |                 |                |                     |                                |
| +290           | H. Blue stem.              | 531              | ?     | 6,659            | 7.6  | 640              | 6.7  | .....    | 3,301           | 200            | 2,352.0             | 11.7                           |
|                | G. 811.....                | 2,376            | 13.0  |                  |      |                  |      |          |                 |                |                     |                                |
| +291           | H. Blue stem.              | 631              | ?     | 6,660            | 3.5  | 719              | 8.0  | .....    | 3,801           | 150            | 1,303.5             | 8.6                            |
|                | G. 811.....                | 2,376            | 13.0  |                  |      |                  |      |          |                 |                |                     |                                |
| +292           | Risting's F...             | 4,910            | ..... | 6,670            | 6.5  | 1,153            | 11.0 | .....    | 5,101           | 300            | 3,173.8             | 10.5                           |
|                | Risting's F...             | 4,941            | ..... |                  |      |                  |      |          |                 |                |                     |                                |
| +293           | Risting's F...             | 5,608            | ..... | 6,660            | 8.0  | 1,201            | 8.0  | .....    | 6,501           | 200            | 2,068.6             | 10.3                           |
|                | Risting's F...             | 4,942            | ..... |                  |      |                  |      |          |                 |                |                     |                                |

\* Varieties originated by straight selection.

† Varieties resulting from handled flowers where the progeny showed no sign of the cross.

‡ Varieties resulting from crosses made in 1892. The three incrosses may not be true crosses.

## BARLEY, VARIETY TESTS.

In collecting, repeatedly testing, and weeding out all but the best varieties of barley to be found we are following the same plan we are pursuing with all the staple field crops in an endeavor to get the best varieties to introduce throughout the state. We care far less to know the relative yields of varieties sold under a certain name than that we may find stocks which will yield best or which will serve as a basis for the production of large yielding sorts by breeding. Only after a few to several trials are we able to pick out those barleys which are adapted to varying conditions of soil and climate or to certain restricted conditions. The effort has been to procure a large number of

stocks or varieties of barley and begin comparing their yields and quality, and as fast as the poor ones are determined throw them away, and as soon as the best kinds are found improve them by selection or cross breeding and then increase the best until we have a quantity sufficient to justify their dissemination by selling the seed in bulk to our farmers at cost of production plus the cost of bags.

TABLE LXVII.—Barley; Variety Tests.

| University No. | VARIETY.           | Source.      | Weight per bushel. | Days maturing. | Stand erect. | Height. | Yield grain per acre.            |                             |             | Average yield, 1894 and 1895, at Co-teau and Univ. |      |
|----------------|--------------------|--------------|--------------------|----------------|--------------|---------|----------------------------------|-----------------------------|-------------|--|------|
|                |                    |              |                    |                |              |         | Grade, 1895, at Univ. & Co-teau. | Yield straw per acre. Tons. | Univ. 1894. |  |      |
| 2              | ?                  | Fargo        | 45                 | 89             | ** *         | 38      | 90                               | .81                         | 35.5        | 54.4   | 44.9 |
| 15             | French Chevalier   | Brandon      | 45                 | 83             | ** *         | 28      | 89                               | 1.29                        | 15.4        | 46.8   | 57.9 |
| 21             | Odessa             | "            | 46                 | 78             | .....        | 30      | 90                               | 1.06                        | 23.5        | 53.7   | 62.5 |
| 7              | Champion of Vt.    | Fargo        | 42                 | 77             | .....        | 31      | 87                               | 1.05                        | 10.8        | 55.9   | 46.9 |
| 26             | ?                  | "            | 42                 | 77             | .....        | 30      | 90                               | .95                         | 14.3        | 49.0   | 49.8 |
| 9              | Highland Chief     | Station      | 44                 | 73             | *            | 29      | 90                               | 1.24                        | 25.5        | 28.1   | 56.5 |
| 12             | Black Hulless      | Fargo        | 58                 | 77             | .....        | 36      | 92                               | .97                         | 10.3        | 41.2   | 49.  |
| 4              | Salzer's           | "            | 47                 | 83             | *            | 29      | 87                               | 1.00                        | 12.1        | 49.9   | 46.6 |
| 27             | Success            | S. Dak.      | 46                 | 77             | .....        | 28      | 88                               | 1.04                        | 19.1        | 40.6   | 47.7 |
| 10             | Chevalier          | Fargo        | 43                 | 83             | ** *         | 30      | 90                               | 1.17                        | 10.4        | 41.6   | 52.3 |
| 26             | Manshury           | Brandon      | 45                 | 78             | .....        | 34      | 87                               | .95                         | 22.9        | 25.8   | 53.7 |
| 23             | Bernard's          | Pipestone    | 47                 | 79             | .....        | 30      | 88                               | .93                         | 20.8        | 34.3   | 45.4 |
| 23             | Golden Grain       | Brandon      | 42                 | 83             | .....        | 29      | 90                               | 1.21                        | 40.5        | 38.2   | 44.8 |
| 19             | Oderbruck          | "            | 47                 | 78             | .....        | 29      | 88                               | .86                         | 17.7        | 36.6   | 43.3 |
| 1              | Highland Chief     | Fargo        | 44                 | 85             | .....        | 38      | 89                               | 1.46                        | 9.2         | 49.0   | 39.2 |
| 5              | New Zealand        | "            | 42                 | 85             | .....        | 29      | 88                               | 1.07                        | 8.5         | 44.4   | 43.9 |
| 9              | Imperial           | "            | 43                 | 78             | .....        | 33      | 85                               | .94                         | 11.0        | 46.2   | 39.4 |
| 13             | Excelsior          | S. Dak.      | 41                 | 77             | .....        | 33      | 84                               | .83                         | 15.2        | 43.4   | 57.8 |
| 18             | Thanet             | Brandon      | 42                 | 83             | .....        | 29      | 86                               | 1.25                        | 11.8        | 37.2   | 46.2 |
| 14             | Kniver's Chevalier | "            | 42                 | 83             | ** *         | 30      | 84                               | 1.10                        | 12.7        | 37.2   | 44.8 |
| 50             | Black              | Station      | 53                 | 78             | .....        | 28      | 92                               | 1.24                        | 21.2        | 28.5   | 43.8 |
| 17             | Ptschara           | Brandon      | 41                 | 77             | .....        | 31      | 74                               | 1.02                        | 13.7        | 34.1   | 44.6 |
| 22             | Sharp's Improved   | "            | 41                 | 83             | .....        | 28      | 88                               | 1.37                        | 16.         | 30.3   | 42.7 |
| 8              | Carter's           | Fargo        | 42                 | 85             | .....        | 29      | 88                               | .88                         | 8.2         | 38.7   | 40.8 |
| 11             | Improved Black     | "            | 58                 | 77             | .....        | 30      | 92                               | 1.30                        | 18.7        | 14.7   | 54.0 |
| 25             | Canadian Thorpe    | Brandon      | 43                 | 84             | .....        | 25      | 88                               | .94                         | 14.1        | 23.7   | 28.3 |
| 3              | Manshury           | Fargo        | 46                 | 85             | .....        | 42      | 90                               | 1.27                        | 13.3        | .....  | 43.3 |
| 16             | Danish Chevalier   | Brandon      | 41                 | 83             | ** *         | 29      | 88                               | 1.15                        | 10.4        | 30.9   | 39.2 |
| 20             | Golden Thorpe      | "            | 41                 | 86             | .....        | 29      | 88                               | 1.10                        | 5.0         | 28.7   | 34.1 |
| 40             | Royal              | Ottawa, Can. | 86                 | .....          | .....        | .....   | .....                            | 2.63                        | .....       | .....  | 55.7 |
| 41             | Surprise           | "            | 86                 | .....          | .....        | .....   | .....                            | 2.19                        | .....       | .....  | 51.5 |
| 42             | Summit             | "            | 90                 | .....          | .....        | .....   | .....                            | 2.13                        | .....       | .....  | 52.5 |
| 43             | Victor             | "            | 87                 | .....          | .....        | .....   | .....                            | 1.09                        | .....       | .....  | 34.4 |
| 44             | Trooper            | "            | 87                 | .....          | .....        | .....   | .....                            | 2.18                        | .....       | .....  | 60.7 |

Varieties marked thus \* \* \* stood up nearly or quite perfectly; with two asterisks, thus \* \*, about 85 per cent. of the grain stood up, and with one asterisk, about 75 per cent. stood well. All varieties not marked were about 60 per cent lodged excepting that the black barley, in all cases, was lodged very badly, being literally flat on the ground.

## OATS, VARIETY TESTS.—1894-5.

Beginning in the spring of 1894 an effort was made to procure the best varieties of oats obtainable. Through the kindness of Prof. J. H. Shepperd of the North Dakota Experiment Station, Director Wm. Saunders of the Dominion Experimental Farms of Canada, Prof. J. F. Hickman of the Ohio Experiment Station, Prof. C. A. Zavitz of Ontario Agricultural College and through other sources we were able to secure a large number of varieties. These were tested at University and Coteau Farms, and by Prof. Shepperd at North Dakota Experiment Station, in 1894 and at both our experiment farms again in 1895, thus making five tests. Some varieties were not recorded during each year as in 1894 drouth did great damage to the plots.

Table LXVIII gives the several yields, the average yields also, the quality of the grain, the ability of the plants to stand erect and the days required to mature. The twelve best of these varieties will again be planted, and the few of these showing best on more extended trial it is our purpose to propagatate in quantity for dissemination. Numerous new sorts are being developed by breeding in our field nursery both by selection and by crossing.

Column 3 gives the average days required to mature the various varieties for three tests; column 5 gives the average of the heights taken of three trials; column 6 gives the average of two trials for yield of straw, and column 12 gives the average yield of grain for five trials, at Coteau, University and North Dakota College Experiment Farms in 1894, and at Coteau and University Experiment Farms in 1895. In column 4 the sign X put opposite the variety of oats signifies that the variety stands erect well and XX signifies that the variety stands erect very well. These notes were made in 1895 in a field where unusual fertility and ample rainfall caused all other varieties to lodge more or less seriously.



TABLE LXVIII.—Oats; Variety Tests.

| University No. | VARIETY.                           | Days maturing. | Stands erect. | Average height of plants. | Average yield of straw per acre, tons | Yield of grains per acre. |                   |                     |                    |                   |
|----------------|------------------------------------|----------------|---------------|---------------------------|---------------------------------------|---------------------------|-------------------|---------------------|--------------------|-------------------|
|                |                                    |                |               |                           |                                       | Coteau farm, 1894.        | Univ. farm, 1894. | N.D.Ex. farm, 1894. | Coteau farm, 1895. | Univ. farm, 1895. |
| 1              | Giant Side.....                    | 98             | .....         | 38                        | 1.22                                  | .....                     | 41.5              | .....               | 50.0               | 62.6              |
| 2              | Wide Awake.....                    | 96             | .....         | 40                        | 1.12                                  | .....                     | 50.0              | .....               | 67.7               | 62.6              |
| 3              | Haggett's White.....               | 94             | .....         | 37                        | 1.38                                  | .....                     | 51.6              | .....               | .....              | 64.0              |
| 4              | Early Swedish.....                 | 83             | X             | 37                        | 1.21                                  | .....                     | 44.0              | .....               | 117.0              | 63.2              |
| 5              | White Russian.....                 | 93             | XX            | 40                        | 1.04                                  | .....                     | 40.6              | .....               | 67.5               | 59.8              |
| 6              | Improved Ligowa.....               | 93             | X             | 39                        | 1.12                                  | .....                     | 45.3              | .....               | 81.7               | 64.3              |
| 7              | Rosedale.....                      | 93             | XX            | 38                        | 1.26                                  | .....                     | 41.9              | .....               | 59.8               | 62.1              |
| 8              | Archangel.....                     | 86             | X             | 35                        | 1.13                                  | 45.8                      | 46.8              | .....               | 56.5               | 63.7              |
| 9              | Prize Cluster.....                 | 85             | .....         | 36                        | 1.23                                  | .....                     | 45.6              | .....               | 53.7               | 50.0              |
| 10             | Abundance.....                     | 94             | X             | 37                        | .99                                   | .....                     | 46.2              | .....               | .....              | 57.8              |
| 11             | Winter Gray.....                   | 85             | .....         | 36                        | 1.09                                  | .....                     | 46.9              | .....               | .....              | 50.6              |
| 12             | Haggett's Seizure.....             | 86             | .....         | 37                        | 1.02                                  | .....                     | 47.8              | .....               | 44.8               | 56.7              |
| 13             | Victoria Prize.....                | 87             | X             | 35                        | 1.19                                  | .....                     | 47.5              | 56.8                | .....              | 55.8              |
| 14             | Challenge White.....               | 88             | X             | 36                        | 1.18                                  | .....                     | 50.3              | 62.2                | .....              | 54.5              |
| 15             | Rennie's Prize White.....          | 82             | .....         | 36                        | 1.56                                  | .....                     | 57.2              | 35.8                | .....              | 56.2              |
| 16             | Banner.....                        | 94             | .....         | 40                        | 1.22                                  | .....                     | 51.8              | 55.7                | .....              | 63.4              |
| 17             | Cream Egyptian.....                | 82             | .....         | 34                        | 1.10                                  | .....                     | 51.9              | .....               | .....              | 50.4              |
| 18             | Welcome.....                       | 82             | .....         | 37                        | 1.23                                  | .....                     | 40.6              | .....               | .....              | 42.9              |
| 19             | White Wonder.....                  | 82             | .....         | 35                        | 1.23                                  | .....                     | 63.1              | .....               | .....              | 44.5              |
| 20             | Bonanza.....                       | 84             | .....         | 38                        | 1.43                                  | .....                     | 56.2              | 42.3                | .....              | 58.1              |
| 21             | Early White Russian.....           | 95             | X             | 38                        | .76                                   | 29.4                      | 33.7              | 55.1                | .....              | 58.0              |
| 22             | New York.....                      | 85             | .....         | 38                        | 1.59                                  | 18.8                      | 46.6              | .....               | .....              | 50.8              |
| 23             | Lincoln.....                       | 92             | X             | 37                        | 1.15                                  | 28.5                      | 48.4              | .....               | .....              | 59.8              |
| 24             | Great Northern.....                | 97             | X             | 37                        | 1.04                                  | .....                     | 34.0              | .....               | .....              | 60.8              |
| 25             | North Star.....                    | 84             | .....         | 35                        | 1.29                                  | 22.9                      | 51.2              | .....               | .....              | 46.7              |
| 26             | Early Gothland.....                | 93             | .....         | 34                        | 1.06                                  | 32.8                      | 45.6              | 77.6                | .....              | 64.5              |
| 27             | Am. White Banner.....              | 90             | .....         | 37                        | 1.43                                  | 33.5                      | 39.4              | 71.0                | .....              | 77.8              |
| 28             | Norrish.....                       | 97             | .....         | 37                        | 1.42                                  | .....                     | 32.2              | 61.5                | .....              | 82.6              |
| 29             | Archangel.....                     | 90             | .....         | 39                        | .92                                   | .....                     | 51.9              | 55.9                | .....              | 82.2              |
| 30             | Improved White Russian.....        | 83             | .....         | 40                        | 1.69                                  | .....                     | 58.7              | .....               | .....              | 69.5              |
| 31             | Probsteir.....                     | 95             | .....         | 36                        | 1.24                                  | .....                     | 41.3              | 68.7                | .....              | 84.4              |
| 32             | White Wonder.....                  | 95             | .....         | 38                        | 1.36                                  | .....                     | 53.7              | 67.3                | .....              | 82.2              |
| 33             | White Russian.....                 | 91             | .....         | 40                        | 1.12                                  | .....                     | 50.0              | .....               | .....              | 71.5              |
| 34             | White Russian.....                 | 95             | X             | 39                        | 1.29                                  | .....                     | 46.6              | 61.9                | .....              | 73.0              |
| 35             | White Russian.....                 | 94             | X             | 39                        | 1.29                                  | .....                     | 46.0              | 63.7                | .....              | 73.0              |
| 36             | Giant Side.....                    | 103            | XX            | 37                        | 1.14                                  | .....                     | 30.1              | 63.9                | .....              | 68.4              |
| 37             | Archangel.....                     | 92             | X             | 35                        | 1.25                                  | 39.9                      | 35.3              | 44.4                | 58.5               | 66.4              |
| 38             | Prize Cluster.....                 | 94             | X             | 35                        | 1.04                                  | 26.9                      | 40.0              | 59.5                | 109.4              | 54.8              |
| 39             | Early Everett.....                 | 96             | .....         | 37                        | .98                                   | 40.0                      | 35.9              | 51.9                | .....              | 69.0              |
| 40             | Early Egyptian.....                | 96             | X             | 39                        | .95                                   | 36.9                      | 35.6              | 55.0                | 52.2               | 72.8              |
| 41             | White Schoenen.....                | 96             | X             | 38                        | 1.07                                  | .....                     | 39.3              | 53.5                | 57.8               | 64.0              |
| 42             | White Wonder.....                  | 92             | .....         | 39                        | .96                                   | .....                     | 39.1              | 45.0                | 55.9               | 61.8              |
| 43             | Wide Awake.....                    | 96             | .....         | 38                        | .93                                   | 34.7                      | 35.9              | 41.5                | .....              | 59.5              |
| 44             | Am. Banner.....                    | 96             | .....         | 38                        | 1.07                                  | 29.9                      | 30.0              | 32.3                | .....              | 70.5              |
| 45             | Progress.....                      | 95             | .....         | 37                        | 1.00                                  | 26.0                      | 35.0              | 51.5                | .....              | 58.0              |
| 46             | Badger Queen.....                  | 93             | .....         | 38                        | 1.35                                  | 25.9                      | 28.2              | 33.0                | 60.6               | 56.2              |
| 47             | Race Horse.....                    | 96             | X             | 36                        | 1.11                                  | 34.7                      | 25.0              | 63.0                | .....              | 63.4              |
| 48             | Salzer's Improved Wh. Russian..... | 96             | .....         | 39                        | 1.10                                  | 29.7                      | 31.9              | 42.5                | 54.6               | 66.0              |
| 49             | Salzer's Welcome.....              | 95             | .....         | 36                        | .89                                   | 21.3                      | 30.9              | 52.0                | 53.3               | 63.4              |
| 50             | Giant Yellow.....                  | 94             | .....         | 35                        | 1.03                                  | .....                     | 40.0              | 60.0                | 57.0               | 61.7              |
| 51             | White Schoenen.....                | 95             | .....         | 38                        | 1.38                                  | .....                     | 45.3              | 53.8                | 44.1               | 66.2              |
| 52             | Black Prolific.....                | 98             | .....         | 38                        | 1.25                                  | 12.0                      | 25.6              | 43.0                | .....              | 80.6              |
| 53             | Am. Beauty.....                    | 97             | .....         | 37                        | 1.06                                  | .....                     | 38.7              | 51.3                | 49.5               | 72.1              |
| 54             | Black Beauty.....                  | 95             | .....         | 37                        | 1.16                                  | 19.0                      | 42.9              | 66.9                | 49.5               | 59.2              |
| 55             | American White.....                | 89             | .....         | 40                        | 1.22                                  | 20.0                      | 43.1              | 59.0                | .....              | 69.2              |
| 56             | Golden Giant Side.....             | 90             | .....         | 36                        | 1.03                                  | 19.4                      | 20.6              | 51.3                | .....              | 66.1              |
| 57             | Archangel.....                     | 95             | .....         | 36                        | 1.11                                  | 28.8                      | 30.9              | 50.0                | .....              | 63.1              |
| 58             | Dogheda.....                       | 96             | .....         | 37                        | 1.06                                  | 29.7                      | 32.5              | 51.5                | 47.2               | 60.9              |
| 59             | Great Northern.....                | 96             | .....         | 35                        | 1.06                                  | 31.3                      | 31.5              | 42.0                | 44.4               | 67.0              |
| 60             | White Bonanza.....                 | 96             | .....         | 37                        | 1.28                                  | 31.5                      | 38.2              | 54.0                | 59.9               | 73.8              |
| 61             | Tartarian.....                     | 95             | .....         | 37                        | 1.27                                  | 31.6                      | 28.7              | 62.3                | 51.4               | 71.5              |
| 62             | White Swede.....                   | 95             | .....         | 38                        | .98                                   | 28.5                      | 41.2              | 60.0                | 58.5               | 69.8              |
| 63             | Black Champion.....                | 04             | .....         | 33                        | .98                                   | 31.3                      | 43.7              | 65.5                | .....              | 79.8              |
| 64             | Black Russian.....                 | 94             | .....         | 37                        | 1.16                                  | 32.8                      | 44.3              | 60.0                | 65.2               | 79.0              |
| 65             | Badger Queen.....                  | 94             | .....         | 42                        | 1.42                                  | .....                     | 44.3              | 35.0                | .....              | 98.7              |
| 66             | Lincoln.....                       | 97             | .....         | 40                        | 1.07                                  | 35.2                      | 47.5              | .....               | 48.4               | 74.4              |
| 67             | Welcome.....                       | 95             | .....         | 40                        | 1.24                                  | .....                     | 53.4              | .....               | 31.2               | 71.7              |
| 68             | Orown Prize Cluster.....           | 95             | .....         | 40                        | 1.27                                  | .....                     | 50.6              | .....               | 46.9               | 65.6              |
| 69             | White Bonanza.....                 | 95             | .....         | 38                        | 1.41                                  | .....                     | 50.6              | .....               | .....              | 62.6              |
| 70             | Black Tartarian.....               | 98             | .....         | 33                        | 1.10                                  | .....                     | 27.5              | .....               | .....              | 56.2              |
| 71             | Seizure.....                       | 100            | .....         | 32                        | .98                                   | .....                     | 19.3              | .....               | 63.3               | 63.2              |
| 72             | Japan.....                         | 96             | .....         | 38                        | 1.66                                  | .....                     | 35.9              | .....               | 93.1               | 61.8              |
| 73             | Horse Mane.....                    | 103            | .....         | 42                        | 1.54                                  | .....                     | .....             | .....               | 56.0               | 63.0              |
| 74             | Green Russian.....                 | 99             | .....         | 41                        | 1.25                                  | .....                     | .....             | .....               | .....              | 59.0              |
| 75             | Early Lincoln.....                 | 94             | .....         | 45                        | 1.53                                  | .....                     | .....             | .....               | .....              | 63.7              |

## PEAS, FIELD; VARIETY TESTS.

In 1895 thirty-three varieties of field peas were planted at University Farm and also at Coteau Farm. The results are given in Table LXIX. A large number of new sorts are being developed from the best of these by breeding, both by depending entirely upon selection, and by crossing and then rigidly selecting the progeny. Most encouraging results have been obtained, as the peas are found to vary greatly in yield of ripe

TABLE LXIX.—Peas; Variety Tests.

| University number. | VARIETY.                  | Source.      | Days matur-<br>ing. | Evenness of<br>ripening. | Vines erect,<br>habit. | Length of<br>vine. | Yield of grain. |                |         |
|--------------------|---------------------------|--------------|---------------------|--------------------------|------------------------|--------------------|-----------------|----------------|---------|
|                    |                           |              |                     |                          |                        |                    | Coteau.         | Univ.<br>farm. | Average |
| 25                 | Prince of Wales.....      | Fargo ..     | 79                  | 91                       | 18                     | 21.7               | 20.3            | 20.3           |         |
| 24                 | White Canada Field.....   | Fargo ..     | 85                  | 90                       | 19                     | 18.6               | 23.             | 20.3           |         |
| 9                  | White Canada Field.....   | University F | 82                  | 89                       | 16                     | 18.9               | 20.7            | 19.8           |         |
| 15                 | Alpha.....                | Fargo ..     | 86                  | 90                       | 13                     | 12.1               | 25.9            | 19.0           |         |
| 19                 | Blue Prussian.....        | Fargo ..     | 90                  | 87                       | 80                     | 36                 | 13.8            | 21.9           | 17.8    |
| 21                 | Crown.....                | Fargo ..     | 82                  | 82                       | 15                     | 13.7               | 21.7            | 17.7           |         |
| 27                 | Green Canada Field.....   | Fargo ..     | 89                  | 92                       | 70                     | 36                 | 16.3            | 18.6           | 17.4    |
| 29                 | Audubon.....              | Audubon..... | 91                  | 92                       | 70                     | 35                 | 18.7            | 16.1           | 17.4    |
| 5                  | Centennial.....           | Brandon..... | 84                  | 87                       | 65                     | 29                 | 16.3            | 18.6           | 17.4    |
| 33                 | Prince Albert.....        | Brandon..... | 92                  | 87                       | 80                     | 36                 | 18.1            | 15.7           | 16.9    |
| 14                 | Black Eyed Marrowfat ..   | Fargo ..     | 85                  | 82                       | 75                     | 36                 | 12.3            | 21.2           | 16.7    |
| 4                  | Prussian Blue .....       | Brandon..... | 88                  | 87                       | 75                     | 33                 | 12.6            | 20.8           | 16.7    |
| 31                 | Potter.....               | Brandon..... | 93                  | 92                       | 75                     | 35                 | 17.5            | 15.4           | 16.4    |
| 7                  | White Canada Field.....   | Brandon..... | 80                  | 87                       | 75                     | 36                 | 16.4            | 16.3           | 16.3    |
| 1                  | Mummy.....                | Brandon..... | 89                  | 90                       | 80                     | 28                 | 15.8            | 16.8           | 16.3    |
| 30                 | Black Eyed Marrowfat....  | Fargo ..     | 100                 | 85                       | 75                     | 48                 | 15.2            | 17.3           | 16.2    |
| 3                  | Crown.....                | Brandon..... | 83                  | 88                       | 20                     | 14.2               | 18.2            | 16.2           |         |
| 22                 | Golden Vine.....          | Fargo ..     | 90                  | 84                       | 80                     | 44                 | 16.7            | 15.5           | 16.1    |
| 26                 | Pride of the Market.....  | Fargo ..     | 80                  | 90                       | 80                     | 22                 | 16.7            | 15.3           | 16.0    |
| 28                 | Blue Field.....           | Fargo ..     | 91                  | 92                       | 70                     | 30                 | 14.7            | 17.1           | 15.9    |
| 20                 | Egyptian Mummy.....       | Fargo ..     | 88                  | 92                       | 85                     | 31                 | 11.2            | 20.0           | 15.6    |
| 18                 | Yorkshire Hero.....       | Fargo ..     | 87                  | 87                       | 80                     | 37                 | 10.8            | 19.7           | 15.2    |
| 2                  | Multiplier.....           | Brandon..... | 88                  | 87                       | 70                     | 30                 | 11.9            | 16.7           | 14.3    |
| 13                 | Golden Vine.....          | Fargo ..     | 86                  | 77                       | 65                     | 36                 | 12.5            | 16.0           | 14.2    |
| 6                  | Pride.....                | Brandon..... | 83                  | 90                       | 15                     | 7.8                | 20.2            | 14.0           | 14.0    |
| 23                 | Tall Gray Sugar.....      | Fargo ..     | 96                  | 90                       | 75                     | 48                 | 10.3            | 17.1           | 13.7    |
| 10                 | Black Eyed Marrowfat ..   | Brandon..... | 88                  | 86                       | 70                     | 33                 | 12.1            | 15.3           | 13.7    |
| 12                 | Blue Imperial.....        | University F | 87                  | 89                       | 75                     | 25                 | 11.3            | 15.7           | 13.5    |
| 8                  | White Eyed Marrowfat....  | University F | 84                  | 87                       | 75                     | 33                 | 10.8            | 15.7           | 13.2    |
| 32                 | Canadian Beauty.....      | Brandon..... | 92                  | 90                       | 70                     | 45                 | 12.5            | 14.1           | 13.3    |
| 11                 | Prince of Wales.....      | University F | 89                  | 92                       | 80                     | 22                 | 13.1            | 13.0           | 13.0    |
| 16                 | Bliss' Evergreen.....     | Fargo ..     | 84                  | 87                       | 14                     | 9.3                | 15.8            | 12.5           | 12.5    |
| 17                 | Horseford's Market Garden | Fargo.....   | 83                  | 88                       | 13                     | 5.8                | 16.4            | 11.1           | 11.1    |

peas and some large yielding individuals have been found which show in the field crop nursery the quality of transmitting large yielding habits to their offspring. The best of the varieties given in Table LXIX will be retained and we shall propagate some of them for distribution, and later on we hope to distribute some of those of our own originating.

## BEANS, VARIETY TESTS.

Field beans have been receiving more attention during the past few years from our farmers than formerly. Believing this to be one of the profitable smaller diversities this experiment station has begun a search for the best varieties, and also an effort to improve the best varieties by breeding them as well as a study of the best ways of raising field beans. The varieties mentioned in Table LXX were planted in 1894 and 1895 at University Farm and part at Coteau Farm in 1894. The yield at University Farm in 1895 is the only fair test, as drouth was so very severe or other conditions were so unfavorable in both other tests that the stand of plants was not uniform, and only the yields of 1895 are given. Were we able to make correct allowances for poor stands of plants the yields of 1895 seem to represent the four yields quite well. However, Choice Medium (University No. 13) and Choice Marrow (University No. 11) are exceptions under the last statement, as these plots had only about half a stand of plants in 1895. Nos. 13 and 14 ripened unevenly which probably accounts for these being marked lower in quality. Early White Marrow (University No. 2); Salzer's White Wonder (University No. 6); Choice Navy (University No. 12); Choice Medium (University No. 13); and Improved Tree Bean (University No. 14) have been selected as representatives of the few classes of beans to be further used in developing varieties by selection and by crossing. A start has been made at originating some new sorts by selecting stocks from a number of the best of the kinds mentioned.

TABLE LXX.—Beans; Variety Tests.

| University No. | VARIETY.                   | Per cent. stand of plants, 1895. | Average days maturing. | Habit of growth. | Quality, 1895. | Size.    | Color.   | Yield per acre in 1895. |
|----------------|----------------------------|----------------------------------|------------------------|------------------|----------------|----------|----------|-------------------------|
| 1              | Boston Pea Beans .....     | 90                               | 84                     | Spreading        | 95             | Small... | White... | 20.3                    |
| 2              | Early White Marrow .....   | 80                               | 94                     | Erect.....       | 95             | Large... | " ..     | 19.3                    |
| 3              | Small Boston Pea Bean..... | 85                               | 87                     | " ..             | 95             | Small... | " ..     | 17.6                    |
| 4              | Snowflake.....             | 90                               | 84                     | " ..             | 90             | " ..     | " ..     | 16.3                    |
| 5              | Early White Navy.....      | 75                               | 81                     | " ..             | 95             | Medium   | " ..     | 20.6                    |
| 6              | Salzer's White Wonder..... | 90                               | 88                     | " & sp'dg        | 95             | " ..     | " ..     | 21.6                    |
| 7              | Early Manly.....           | 80                               | 91                     | " ..             | 95             | Small... | " ..     | 19.6                    |
| 8              | Burlingame Medium.....     | 80                               | 88                     | " ..             | 95             | Medium   | " ..     | 18.3                    |
| 10             | Swede.....                 | 75                               | 88                     | " ..             | 95             | Large... | Deep yel | 14.0                    |
| 11             | Choice Marrow.....         | 40                               | 94                     | " ..             | 95             | " ..     | White... | 13.3                    |
| 12             | Choice Navy.....           | 80                               | 83                     | " & sp'dg        | 95             | Small... | " ..     | 20.0                    |
| 13             | Choice Medium.....         | 50                               | 84                     | " ..             | 90             | Medium   | " ..     | 13.3                    |
| 14             | Improved Tree Bean.....    | 65                               | 82                     | " ..             | 90             | Small... | " ..     | 16.6                    |

## FIELD ROOT CROPS.

An effort is being made to learn how our farmers can cheapest and best raise large yields of root crops for stock. On University farm and on most farms observed by the writer in the northwest, yields of field roots have been comparatively small, except on soils highly fertilized with barnyard manure. On lands which are almost too rich for cereal crops the crops of roots have as a rule been only moderate. We have set out to discover why this is so and if possible to show our farmers how to produce roots so cheaply that far more will be raised. Unless roots can be raised very cheaply it is not economy to use them in the food ration for live stock for more than a small proportion of the ration. Fed in small quantities with other foods, roots add that succulence to the ration which increases the appetite, stimulates digestion and encourages more hearty assimilation in the tissues. The succulent foods add tone to the system and, besides the value of the dry matter of the roots as food substance, they have an influence in aiding animals to get out of the dry food with which the roots are fed more than they could secure if fed the dry food alone. Only a comparatively small proportion of the ration should be roots in ordinary feeding, unless they are very cheap, since if they are used in large quantities the ration would be made more expensive than it would be if our cheap grains and roughage were mainly used. The Hand Book of Experiment Station Work, 1893 in giving the average analysis of mangels, gives the dry matter as 9.1 per cent. and of water 90.9 per cent.; of turnips the dry matter is given as 9.5 per cent., of rutabagas, 11.4 per cent.; of carrots, 11.4 per cent. and of sugar beets, 13.5 per cent.; while potatoes are given as 21.1 per cent. dry matter. In Bulletin No. 42 of this station Prof. Snyder gives the average analysis of Minnesota potatoes at 24.55 per cent dry material and 75.45 per cent. water. The Hand Book of Experiment Station Work gives the average dry material in timothy hay at 86.8 per cent., of red clover 84.7 per cent. and of wheat and oat straw at 90.4 and 90.8 per cent., respectively. Corn stover, husked corn fodder, is given at 59.9 per cent. and silage of corn is given at 20.9 per cent. dry material.

Red clover before bloom and not dried is given at 38 per cent. and timothy in the same stage, undried, at 30.1 per cent. dry material. The grains are given as follows: Corn, 89.1 per cent.; barley, 89.1; oats, 89; wheat bran, 83.1, and linseed meal, 90.8 per cent. dry, or water free material.

Reducing these to pounds of dry matter per ton and yields per acre we have the figures as shown in the following table.

TABLE LXXI.—Comparison of Different Classes of Root Crops and Other Foods.

|                                 | Dry material,<br>per cent. | Water, per cent. | Dry material<br>in one ton. | Average tons<br>per acre.<br>See table B. | Dry matter<br>produced on<br>an acre, lbs. |
|---------------------------------|----------------------------|------------------|-----------------------------|---|--|
| Mangels.....                    | 9.1                        | 90.9             | 182                         | 11.44                                     | 2,220                                      |
| Turnips.....                    | 9.5                        | 90.5             | 190                         | 8.2                                       | 1,558                                      |
| Rutabagas.....                  | 11.4                       | 88.6             | 228                         | 10.3                                      | 2,326                                      |
| Carrots.....                    | 11.4                       | 88.6             | 228                         | 5.8                                       | 1,322                                      |
| Sugar beets.....                | 13.5                       | 86.5             | 270                         | 8.1                                       | 2,187                                      |
| Potatoes.....                   | 24.5                       | 75.5             | 480                         |   |  |
| Timothy hay.....                | 86.8                       | 13.2             | 1,736                       |   |  |
| Red clover hay.....             | 84.7                       | 15.3             | 1,694                       |   |  |
| Wheat straw.....                | 90.4                       | 9.6              | 1,808                       |   |  |
| Oat straw.....                  | 90.2                       | 9.8              | 1,804                       |   |  |
| Corn stover.....                | 59.9                       | 40.1             | 1,198                       |   |  |
| Corn silage.....                | 20.9                       | 79.1             | 418                         |   |  |
| Green clover before bloom.....  | 38.0                       | 42.0             | 760                         |   |  |
| Green timothy before bloom..... | 30.1                       | 49.9             | 602                         |   |  |
| Maize kernels.....              | 89.1                       | 10.9             | 1,782                       |   |  |
| Barley.....                     | 89.1                       | 10.9             | 1,782                       |   |  |
| Oats.....                       | 89.0                       | 11.0             | 1,780                       |   |  |
| Wheat bran.....                 | 88.1                       | 10.9             | 1,762                       |   |  |
| Linseed meal.....               | 90.8                       | 9.2              | 1,816                       |   |  |

Column five in Table LXXI gives the average yields of the various classes of root crops grown in the variety tests. Column six gives the amount of dry matter found by multiplying the dry matter in one ton into the average number of tons per acre as grown in our variety tests. The results are surprising in that they show nearly as large yields of dry matter from sugar beets as from mangels and from rutabagas. In the following table are given the yields of varieties of the several crops. An effort has been begun to produce large yielding stock beets. For this purpose we are seeking for the larger kinds, as well as of sugar beets and other roots having a large content of dry matter, so as to increase the yield of dry matter per acre. Breeding experiments looking to this end are to be begun and for this purpose numerous kinds of seed have been procured.

## ROOT CROPS, VARIETY TESTS.

In 1896 a number of varieties of the various classes of field roots were planted and the yields are given in Table LXXII. As they are arranged under each class in the order of their greatest yields, no further comment is necessary.

TABLE LXXII.—Root Crops; Variety Tests.

| Plot No.            | Variety.                         | Source.  | Days maturing. | Yield roots per acre. |
|---------------------|----------------------------------|--|----------------|-----------------------|
| Mangles.            |                                  |  |                |                       |
| 1                   | Champion Yellow Globe.....       | Northrup, Braslan & Goodwin Co.,<br>Minneapolis.....   | 129            | 18.2                  |
| 8                   | Prize Champion Globe.....        | W. W. Barnard & Co., Chicago.....                      | 129            | 12.8                  |
| 4                   | Red Globe.....                   | Northrup, Braslan & Goodwin Co.,<br>Minneapolis.....   | 129            | 12.3                  |
| 2                   | Mammoth Golden Giant.....        | Northrup, Braslan & Goodwin Co.,<br>Minneapolis.....   | 129            | 11.9                  |
| 6                   | Eiffel Tower.....                | John A. Salzer, La Crosse.....                         | 129            | 11.3                  |
| 5                   | Mammoth Long Red.....            | Northrup, Braslan & Goodwin Co.,<br>Minneapolis.....   | 129            | 11.2                  |
| 3                   | Golden Tankard.....              | Northrup, Braslan & Goodwin Co.,<br>Minneapolis.....   | 129            | 11.0                  |
| 7                   | Holstein.....                    | John A. Salzer, La Crosse.....                         | 129            | 10.4                  |
| 10                  | Golden Giant.....                | Northrup, Braslan & Goodwin Co.,<br>Minneapolis.....   | 129            | 10.3                  |
| 11                  | Long Red.....                    | Northrup, Braslan & Goodwin Co.,<br>Minneapolis.....   | 129            | 10.2                  |
| 12                  | Golden Tankard.....              | Northrup, Braslan & Goodwin Co.,<br>Minneapolis.....   | 129            | 10.1                  |
| 9                   | Long Yellow.....                 | W. W. Barnard & Co., Chicago.....                      | 129            | 7.6                   |
| Sugar Beets.        |                                  |  |                |                       |
| 13                  | Dippes, Klein Wanzleibeiner..... | U. S. Dept. of Agriculture, Wash-<br>ington, D. C..... | 129            | 8.9                   |
| 14                  | Vilmorins Richest.....           | U. S. Dept. of Agriculture, Wash-<br>ington, D. C..... | 129            | 7.3                   |
| Turnips, Varieties. |                                  |  |                |                       |
| 15                  | Purple Top White Globe.....      | Northrup, Braslan & Goodwin Co.,<br>Minneapolis.....   | 118            | 13.6                  |
| 17                  | White Strap Leaf.....            | W. W. Barnard & Co., Chicago.....                      | 118            | 13.0                  |
| 20                  | Yellow Globe.....                | Northrup, Braslan & Goodwin Co.,<br>Minneapolis.....   | 118            | 7.3                   |
| 18                  | Pomeranian White Globe.....      | W. W. Barnard & Co., Chicago.....                      | 118            | 7.3                   |
| 22                  | White Flathorfolk.....           | W. W. Barnard & Co., Chicago.....                      | 118            | 7.3                   |
| 16                  | White Globe.....                 | Northrup, Braslan & Goodwin Co.,<br>Minneapolis.....   | 118            | 6.3                   |
| 21                  | White Norfolk.....               | Northrup, Braslan & Goodwin Co.,<br>Minneapolis.....   | 118            | 6.0                   |
| 19                  | Purple Top Yellow Aberdeen.....  | Northrup, Braslan & Goodwin Co.,<br>Minneapolis.....   | 118            | 4.6                   |
| Rutabagas.          |                                  |  |                |                       |
| 26                  | Lang's Improved Purple Top.....  | W. W. Barnard & Co., Chicago.....                      | 118            | 12.7                  |
| 23                  | Monarch.....                     | Northrup, Braslan & Goodwin Co.,<br>Minneapolis.....   | 118            | 9.8                   |
| 25                  | American Purple Top.....         | W. W. Barnard & Co., Chicago.....                      | 118            | 9.6                   |
| 24                  | White Sweet Russian.....         | W. W. Barnard & Co., Chicago.....                      | 118            | 9.0                   |
| Carrots.            |                                  |  |                |                       |
| 28                  | Danver's Half Long.....          | W. W. Barnard & Co., Chicago.....                      | 118            | 7.3                   |
| 27                  | New Chantenay.....               | W. W. Barnard & Co., Chicago.....                      | 118            | 5.8                   |
| 29                  | Improved Long Orange.....        | W. W. Barnard & Co., Chicago.....                      | 118            | 4.4                   |

## ROOT CROPS, DEPTH TO PLANT.

Table LXXIII gives the results of an experiment undertaken to determine the depth to plant the seeds of root crops in this climate. Each kind of seed was planted at the depth of one-half, one, and one and one-half inches. As shown by the table

TABLE LXXIII.—Root Crops; Depth to Plant.

| Plot No.          | VARIETY.                  | Depth plant-<br>ed. Inches. | Yield per<br>acre. |
|-------------------|---------------------------|-----------------------------|--------------------|
| <b>Mangels.</b>   |                           |                             |                    |
| 30                | Holstein.....             | ½                           | 13.1               |
| 31                | ".....                    | 1                           | 10.8               |
| 32                | ".....                    | 1½                          | 8.3                |
| <b>Rutabagas.</b> |                           |                             |                    |
| 33                | Monarch.....              | ½                           | 14.0               |
| 34                | ".....                    | 1                           | 12.5               |
| 35                | ".....                    | 1½                          | 11.8               |
| <b>Turnips.</b>   |                           |                             |                    |
| 36                | White Flat Norfolk.....   | ½                           | 9.1                |
| 37                | ".....                    | 1                           | 10.5               |
| 38                | ".....                    | 1½                          | 10.5               |
| <b>Carrots.</b>   |                           |                             |                    |
| 39                | Improved Long Orange..... | ½                           | 7.8                |
| 40                | ".....                    | 1                           | 6.5                |
| 41                | ".....                    | 1½                          | 3.4                |

the shallowest planting gave the largest yields and the deepest planting the poorest in the mangels, rutabagas and carrots, while in the turnips the deepest and the medium depths gave slightly better results than the shallower planting.

## ROOT CROPS, DISTANCE APART OF ROWS.

Plots of turnips, mangels and rutabagas were planted 18, 24, 30 and 36 inches apart and were thinned to a uniform thickness of about 4 inches apart in the rows. Table LXXIV gives the yields. The land on which all these roots grew is a fair mixture of sand and clay, if anything a little heavy in character. The closer the rows of turnips the better was the yield. The rutabagas yielded best at 24 inches apart. In the case of the mangels the yield was best where the rows were 30 inches apart.

TABLE LXXIV.—Root Crops; Distance Apart of Rows.

| PLOT.    | CROP.          | VARIETY.             | Distance<br>apart of rows. | Yield<br>per acre, tons. |
|----------|----------------|----------------------|----------------------------|--------------------------|
| 42b..... | Turnips.....   | White Norfolk.....   | 18                         | 25.9                     |
| 43b..... | ".....         | " ".....             | 24                         | 23.1                     |
| 44b..... | ".....         | " ".....             | 30                         | 22.3                     |
| 45b..... | ".....         | " ".....             | 36                         | 21.9                     |
| 42c..... | Rutabagas..... | White Sweet Russian. | 18                         | 32.5                     |
| 43c..... | ".....         | " ".....             | 24                         | 36.1                     |
| 44c..... | ".....         | " ".....             | 30                         | 27.8                     |
| 42d..... | Mangels.....   | Mam. Long Red.....   | 18                         | 18.7                     |
| 43d..... | ".....         | " ".....             | 24                         | 18.8                     |
| 44d..... | ".....         | " ".....             | 30                         | 21.5                     |
| 45d..... | ".....         | " ".....             | 36                         | 21.2                     |

## RAPE, VARIETY TESTS.

In 1895 numerous varieties of rape were planted that we might learn more as to the different varieties of this crop. Table LXXV gives the yields and number of days required by each kind to reach that size, and degree of maturity necessary for pasturage. If they had been actually pastured the yield of green matter would have been larger as considerable growth would have taken place during the season the rape was being pastured down. The plots recorded in the table were planted June 7th on good clay loam land in drills eighteen inches apart and nearly two pounds of seed per acre were used. These same varieties were again planted in duplicate plots on July 3d, but the midsummer being dry these plots made very little growth and no record of weights was made.

TABLE LXXV.—Rape; Variety Tests.

| Univ. No. | VARIETY.                     | Days matur-           | Yield green               |
|-----------|------------------------------|-----------------------|---------------------------|
|           |                              | ing for past-<br>ure. | forage per<br>acre, tons. |
| 1         | Dwarf Essex.....             | 73                    | 18.3                      |
| 2         | Fukushima.....               | 69                    | 9.9                       |
| 3         | Hoki.....                    | 64                    | 11.6                      |
| 4         | Shica.....                   | 64                    | 10.2                      |
| 5         | Cifu.....                    | 64                    | 8.2                       |
| 6         | Colza (ordinary).....        | 73                    | 12.6                      |
| 7         | Colza (parapleri).....       | 73                    | 12.2                      |
| 10        | Colza (Nalnde Hamburg).....  | 73                    | 8.6                       |
| 17        | German Winter.....           | 73                    | 3.2                       |
| 18        | Colza. Yellow Flowering..... | 73                    | 2.3                       |
| 19        | Colza. White Flowering.....  | 73                    | 5.2                       |



In point of yield the Dwarf Essex variety was decidedly the best in the tests. Numbers 2, 3, 4 and 5 were received from the Japanese Consul in charge at the World's Fair. These and several other varieties were planted in our field crop nursery where a cursory study was made of the variation of the individual plants. It was observed that plants of these varieties show quite as much individual variation as do other field crops. It is less practicable to breed the biennial varieties here than it would be in Oregon or other sections where the seed is raised. There is a strong growing demand for rape seed in this country and sections which can mature it should at once begin to supply us with seed. Experiment stations situated so that they could improve the size or yield and other qualities of this plant should study the requirements of the crop and breed up varieties especially suited to the needs of this climate. This station would gladly co-operate in working up methods of improvement and in testing improved varieties of rape with any station in a state suited to growing rape seed which cares to take up the experiments in the production of seed of better varieties to be grown by their farmers to produce seed for the farmers of the states suited to growing rape. Whenever the sheep business again makes advancement seeds of this crop will be in good demand. Unlike Dwarf Essex, which is without a rival as the best variety of rape for green forage, some varieties produced seed the year they were sown and further experiments may prove them worthy to grow in this climate for the production of seed for oil and cake and food for pet birds.

## SMUT IN WHEAT.

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WILLET M. HAYS.

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In 1894, and again in 1895, this Station issued a bulletin calling the attention of the farmers of the state to the great damage wheat bunt or stinking smut is doing to the wheat raiser and the wheat and flour trade of the state. Remedies were given and the very slight cost of treatment, as compared with the benefit, was pointed out. The wholesale dealers in blue-stone report a strongly growing demand for this remedial material. Last season over forty thousand copies of our special bulletins were issued and the remedies were copied by numerous papers circulating among the farmers and the agricultural and country press generally discussed the matter and advised farmers to blue stone their seed wheat. In spite of all this the natural spreading of wheat smut has gone on more rapidly than the destruction. Farmers and owners of threshing machines are most negligent. Farmers too often do not inspect their seed to see if it is smutted. They too often use for seed, without treatment and sometimes without cleaning, wheat which has come from a smutted field or has run through a threshing machine which has previously threshed smutted wheat. The comparatively few smut spores gotten from the infested threshing machine multiply in a few years and the farmer's whole crop becomes badly smutted. Wheat purchased for seed from an elevator or from a neighbor may have only a small amount of smut, but in a few years the disease may so multiply as to seriously infest the entire crop.

Bunt or stinking smut of wheat is a disease caused by small spores. These are very small, seed like, spherical bodies which are produced in the diseased kernels of wheat. These kernels are broken in threshing and handling the grain and the minute spores scattered about cling to the grains of wheat. When the wheat is sown the spores germinate much

like small seeds, and some of them, lying on the kernel against the sprouting plantlet, send their thread-like stems into the wheat plant. Here the disease thrives, branches, grows upward as the wheat grows, and when the wheat forms its seeds some of the branches of the smut will have found their way into the kernels of wheat. Here it develops its seed like spores, and when the grain is ripe the diseased kernel of wheat is a mass of smut spores enclosed in the shrunken or even enlarged wheat bran. These spores or germs live until the next year. If chance favors them they germinate on another young and tender wheat plant. These smut spores are very small and we cannot dislodge all of them from the seed grains by thoroughly cleaning the wheat. Some method of destroying them by heat or by the use of fungicides is necessary.

#### EXPERIMENTS IN TREATING SMUTTY SEED WHEAT.

In 1895 a quantity of very smutty Fife wheat was secured and on April 24th twenty-four plots of about one-thirtieth of an acre each were planted on good and uniform soil—Field H, series I, University Farm. The soil had borne our nursery crop of field peas the year before, which was practically a hoed crop, as the plants were three feet apart each way. All plots grew uniformly and the comparison was fair and successful in so far as we could judge. The blue-stone dipping method, the blue-stone sprinkling method, the hot water treatment, and a few other remedies were tried. The table below explains the kind and manner of treatment and gives the results. The main effort was to find the best methods of applying the simple remedies we advised a year ago. Plots 2, 7, 13 and 22 were untreated. We used a very smutty sample of seed wheat, without cleaning, for all plots; but another season we shall try the various remedies on very smutty, on slightly smutty and on clean wheat that we may get the effect of the various remedies on the good grain as well as on grain more or less diseased. All the percentages of smut in the table would be very much lower if the wheat had been cleaned, and the effectiveness of all the better methods would doubtless have been almost perfect.

Table LXXVI.—Treatment of Smutty Seed Wheat.

| Plot No. | Manner of Treatment.   | Grains germinated per sq. yd. | Yield straw per acre. | Yield grain per acre. | Per cent. smutted. |
|----------|--|-------------------------------|-----------------------|-----------------------|--------------------|
| 1        | ½ lb. blue-stone in 24 lbs. water sprinkled on 10 bu. wheat....  | 231                           | 1.1                   | 31.7                  | 6.5                |
| 2        | Untreated.....   | 233                           | 0.6                   | 26.9                  | 20.6               |
| 3        | 1 lb. blue-stone in 24 lbs. water sprinkled on 10 bu. wheat....  | 214                           | 0.8                   | 28.8                  | 2.4                |
| 4        | 2 lbs. blue-stone in 24 lbs. water sprinkled on 10 bu. wheat.... | 166                           | 0.9                   | 30.1                  | 1.2                |
| 5        | Same as 1st and dried by rolling in air slaked lime.....         | 227                           | 1.0                   | 33.6                  | 1.5                |
| 6        | Same as 1st and dried by rolling in land plaster.....            | 215                           | 0.8                   | 27.5                  | .5                 |
| 7        | Untreated.....   | 185                           | 0.6                   | 21.8                  | 13.4               |
| 8        | ½ lb. blue-stone dissolved in 16 lbs. water, wheat dipped.....   | 172                           | 0.9                   | 31.4                  | 2.9                |
| 9        | 1 lb. blue-stone dissolved in 16 lbs. water, wheat dipped.....   | 101                           | 0.9                   | 31.5                  | .9                 |
| 10       | 2 lbs. blue-stone in 16 lbs. water, wheat dipped.....            | 96                            | 0.8                   | 28.8                  | .8                 |
| 11       | Same as 8th, but wheat dried in lime.....                        | 150                           | 0.9                   | 31.7                  | .1                 |
| 12       | Same as 8th, but wheat dried in land plaster.....                | 193                           | 0.9                   | 29.9                  | .2                 |
| 13       | Untreated.....   | 246                           | 0.6                   | 22.2                  | 13.2               |
| 14       | Soaked 15 minutes in saturated solution of common salt.....      | 211                           | 0.8                   | 29.1                  | 3.3                |
| 15       | Soaked in water at temperature of 50 deg. F. for 15 minutes.     | 212                           | 0.7                   | 25.1                  | 10.4               |
| 16       | Soaked in water at 120 deg. for 10 min. and 130 deg. 5 minutes.  | 194                           | 0.9                   | 32.3                  | .5                 |
| 17       | Soaked in water at 120 deg. 10 min., and at 130 deg. 10 minutes. | 193                           | 0.9                   | 31.4                  | .4                 |
| 18       | Soaked in water at 120 deg. 10 min., and at 130 deg. 5 minutes.  | 169                           | 0.8                   | 26.5                  | .3                 |
| 19       | Soaked in water at 120 deg. 10 min., and 133 deg. 10 minutes.... | 217                           | 0.8                   | 27.4                  | .3                 |
| 20       | Soaked in water at 120 deg. 10 min., and 135 deg. 5 minutes....  | 151                           | 0.8                   | 27.7                  | .3                 |
| 21       | Soaked in water at 120 deg. 10 min., and 135 deg. 10 minutes.... | 139                           | 0.7                   | 25.6                  | .1                 |
| 22       | Untreated.....   | 227                           | 0.6                   | 19.6                  | 11.0               |
| 23       | Soaked in water at 120 deg. 2 min., and 135 deg. 2 minutes.....  | 177                           | 0.7                   | 24.8                  | .4                 |
| 24       | Soaked in water at 120 deg. 2 min., and 133 deg. 2 minutes.....  | 180                           | 0.7                   | 24.5                  | .5                 |

## SUMMARIES FROM THE TABLE.

(1) So many of the kernels in the crop on untreated plots were smutted and therefore light, or possibly the disease had such a depressing effect on the plants, that they did not yield nearly as well as the treated plots. The four untreated plots averaged 22.6 bushels, while the average of all plots treated with blue-stone by the dipping and the sprinkling methods was 30.5 bushels per acre, a gain of 8 bushels, for the cost of one to one-and-a-half cents worth of blue-stone and the labor of treating one and one-fourth bushels of wheat. Besides this 14.5 per cent. of the kernels in the four untreated plots were smutted, while only 1.5 per cent. of those in the ten plots treated in various ways with blue-stone were thus affected.

(2) The six plots Nos. 16, 17, 18, 19, 20 and 21 treated in nearly the ordinary way of hot water treatment yielded 28.5 bushels as compared with the 22.6 bushels of the four untreated plots, and 30.5 bushels of the ten treated with blue-stone, and the wheat was only 0.3 per cent. smutted as against 14.5 per cent. in the untreated and 1.7 per cent. in that treated with blue-stone.

(3) The five plots treated with blue-stone by the sprinkling method yielded 30.3 bushels per acre, while the five treated by the dipping method yielded 30.7 bushels and of the former 2.4 per cent. of the kernels were smutted and of the latter only 1 per cent.

(4) By the sprinkling method blue-stone dissolved in 24 lbs. of water and sprinkled on ten bushels of wheat, was more effective when two pounds of the blue-stone were used than when only one was used and one pound was more effective than one-half pound in 24 lbs. water for each ten bushels of seed.

(5) By the dipping method, two pounds of blue-stone in sixteen pounds of water or only one pound were nearly equally effective, but both were considerably more effective than when the solution contained only one-half pound blue-stone to 16 pounds water.

(6) The average yield of two plots treated with one-half pound blue-stone to ten bushels of wheat, one by the sprinkling and one by the dipping method, is 31.6 bushels per acre and the average per cent. of smutted kernels is 4.7 per cent. Where the wheat was given the same treatment with blue-stone and dried by means of air slaked lime the yield was 32.7 bushels and the percentage of smut was .8 per cent. Where the drying was done by means of land plaster the average yield was only 28.7 bushels while there was only .4 per cent. of smutted kernels.

(7) The plot treated by soaking the wheat in a saturated solution of common salt yielded 29 bushels per acre and had 3.3 per cent. of smutted kernels.

(8) The wheat raised from seed soaked for fifteen minutes in water at a temperature of 50 deg. F. yielded only 25.1 bushels per acre of which 10.4 per cent. was smutted. The only good probably arose from the cleansing by the water.

(9) Of the wheat soaked in water at a 120 deg. F. for ten minutes, the average of two plots, afterwards soaked in water at 130 deg. F. five and ten minutes respectively, and dried before sowing, was 31.8 bushels of wheat with .5 per cent. smut; that similarly soaked in water at a temperature of 133 deg. F. yielded an average of 27 bushels of wheat containing .3 per cent. smutted kernels; and that soaked in water at 135 deg. F. yielded 26.7 bushels containing only .2 per cent. of smut.

(10) On the three plots treated with water at 120 deg. F. for ten minutes and at 130 deg., 133 deg. and 135 deg. respectively, for five minutes the average yield was 28.8 bushels and the per cent. of smut was 4. per cent. On those similarly treated, except that the seed was left in the hot water ten minutes instead of five the yield was 28.1 and contained .3 per cent. smut.

(11) Two plots soaked in water at 120 deg. F. for two minutes and in water at 133 deg. and 135 deg. for two minutes respectively the average yield was 24.6 bushels and the smut .5 per cent.

#### REMEDIES FOR WHEAT SMUT.

Where practicable choose wheat which has no smut, or which has comparatively little. Clean the wheat thoroughly by running through a fanning mill with the "blast" turned on strong so as to blow out as many as possible of the bunt kernels, or use any other efficient means for cleaning. It is often necessary to treat the seed for successive years before the farm is free from the disease.

#### THE BLUE-STONE SPRINKLING METHOD.

Dissolve one pound of blue-stone (copper sulphate) in two and one-half gallons of water. Spread out ten bushels of wheat on a tight floor in barn or house or in a tight wagon-box and with broom, sprinkling pot or with pail or dipper, sprinkle on the solution. With scoop-shovel turn the grain several times during the sprinkling till every kernel is thoroughly wetted. The solution needs to penetrate even the hairs at the blossom end of each kernel and to penetrate the crease in the grain. In three hours the wheat will be ready for the seeder and as the blue-stone somewhat injures the seed it should not be prepared long before it is sown. A good plan is to prepare in the evening the seed to be used the next day. That prepared in the morning can be used in a few to several hours, or if dried with lime, plaster or dust, it may be used in half an hour. By hand or in some machines it may be seeded almost at once without drying, though it should remain wet in the solution half an

hour or more that the blue-stone may have time to kill the smut spores. As the seed is somewhat swollen a few quarts more per acre should be sown than of dry wheat. The blue-stone solution can be made by the barrel, using care to get the right proportions of blue-stone and water, and then it can be measured out one ten quart pail full to each ten bushels of wheat. The wheat should be turned four or five times within an hour after sprinkling. If a water-tight floor is not available the solution should be sprinkled on slowly so that little or none runs through.

#### THE BLUE-STONE DIPPING METHOD.

Fill a barrel two-thirds full of the solution of one pound of blue-stone (sulphate of copper) to two to four gallons of water, using the weaker solution for wheat little or none affected and a stronger solution for wheat badly smutted. Partially fill gunny sacks or other open receptacle with wheat and immerse in the solution for a few minutes, moving the sack up and down and shaking or kneading it so that every kernel is thoroughly wetted, stirring if necessary. Place sacks or other receptacles containing the wet wheat where the solution will drain out. If convenient catch and save the drip. The solution should reach all surfaces of every kernel and it is desirable to have the wheat as little wet as necessary to avoid trouble in drying. When the water ceases dripping pour the wheat on the barn floor and shovel every few hours till dry enough to sow, or if to be kept some days, dry thoroughly enough to store without danger of heating. The drying may be facilitated by mixing with the wet wheat land plaster or slaked lime, or even dust or ashes which contain no grit which might injure the feeding device of the seeding machine. Slaked lime stops the action of the blue-stone and it should not be applied till after the solution has been on the wheat for half an hour. The lime not only helps to dry the wheat but stops the slightly injurious action of the blue-stone on the seed. It is necessary to renew the quantity of the solution, and for this purpose the prepared solution may be kept ready in other barrels.

## THE HOT WATER METHOD.

Fill two barrels or washtubs two-thirds full of water. Keep the water in No. 1 at 120 degrees Fahr. and No. 2 at 130 to 135 degrees. Fill gunny sacks, or bags of other open-meshed material, partly full of wheat; immerse in No. 1 till the wheat is warmed up so as to not cool the water in No. 2; drain the bag a few seconds and then immerse in No. 2 for five minutes, raising and lowering the bag or kneading the wheat, so that the water thoroughly penetrates to and heats every kernel. Spread out at once and shovel over until dry. It is a good plan to dip the bag of wheat in cool water, so as at once to cool the wheat. Care must be taken to add hot water so as to keep the water in No. 2 at 130 to 135 degrees F.; 133 degrees is the temperature preferred. This is the most practical way of treating smutty seed oats and gives good results in treating smutty wheat. Where warm rooms enable one to dry the wheat, this would be the best plan by which to get the wheat ready during winter.

Blue-stone is offered by local druggists and grocers at eight to ten cents per pound in Minnesota, possibly twelve cents where freights are highest. This makes the cost only about a cent to a cent-and-a-half per acre for blue-stone. The above table shows that blue-stone not only causes the wheat to yield more, if the seed is badly infested, but the grades are better. And with clean wheat grades can far better be maintained in the local and in the terminal market, and the No. 1 hard reputation of our wheat abroad can only be maintained with smutless grain.

It is not only a duty a farmer owes himself, but to the state and to the country to market only good wheat. The remedies given above have been tried by many and the large number of commendations and no criticisms, show that they are practical and very useful. The experiments above reported show remarkable benefits. It will doubtless pay to treat nearly every bushel of wheat sown in Minnesota. For wheat only slightly affected, the solution of blue-stone should be only half or two-thirds as strong as recommended above as this substance slightly injures the vitality of the wheat. In smutted wheat the benefit is far greater than the harm.



## CROSS ROTATION EXPERIMENTS.

WILLET M. HAYS.

In 1894 a field of twelve acres was divided into six series, numbered II, III, IV, V, VI and VII, each containing twelve plots of about one-seventh of an acre, the plots being 3 by 8 rods. The series are separated by alleys a rod wide, thus allowing ample room for turning all machines at the ends of the plots. In 1894 the series were each planted to a different kind of staple crop. The series run north and south. The east one was planted to field peas, the next to mangel wurzels, the next to potatoes, the next to flax, the next to wheat and the west one was planted to corn. Each series was planted and cultivated alike in all its parts. At harvest time each series was divided into twelve plots by lines running east and west across all the series. By recording the yield of each crop on each of the twelve plots in each series we obtained a record of the fertility or crop producing power of each plot. The land was nearly level and uniform in richness. Some lower portions were less effected by drouth than other slightly higher portions. The season was very dry and the yields were somewhat less uniform than would have been the case during a year of more moisture. In other words, the lower moister places were able to produce proportionately slightly greater yields than they would have borne had the supply of moisture been better. The general results, however, of the experiment are so decisive and so thoroughly fortified by the many duplicates in the seventy-two plots that these differences due to individual variation in the fertility of the plots are largely eliminated.

In 1895 the same crops as in 1894 were planted on this field though at right angles in belts across the series as planted the previous season, thus bringing each crop following each of the six crops. The series having been divided into twelve plots each in 1894 enabled us to plant the crops in duplicate in 1895. Thus the peas were on plots one and seven of each series and the corn was on plots six and twelve. In the Table LXXXVIII, all these duplicate yields given in Table LXXVII are collected into averages. The same plot lines were preserved as used in 1894, thus giving the yield in 1895 of each crop on separate plots of land bearing each crop in 1894. The influence of each

crop on each future crop is thus found, and by this means we learn in which order of succession to arrange the crops in the rotation. No effort was made by analysis in this particular experiment to find the actual amount of plant food used up by each crop, but rather in what condition each crop leaves the land for each of the several succeeding crops. The field had borne a good crop of corn in 1893. The peas were of the small white Canada sort and were sown broadcast at the rate of two bushels per acre and were plowed under four inches deep. The land was spring plowed for the mangel wurzels, which were planted in drills two and one-half feet apart. The potatoes were planted with a potato planter on fall plowed land in drills three feet apart. The flax in 1894 was sown on disked corn stubble land and in 1895 on fall plowed land with a drill at the rate of three pecks per acre. The wheat was sown on fall plowed corn stubble land in 1894 and in 1895 on fall plowed land on the various series, and was drilled in with a Dowagiac shoe drill at the rate of one and one-fourth bushels per acre. The corn was planted on fall plowed corn stubble land in 1894, and in 1895 on fall plowed land following the various crops.

Table LXXVII shows the exact form of the field, and the form, position and yield of each plot. The 1894 yields are given in common type while those of 1895 are given in full-faced type.

TABLE LXXVII.—Cross Rotation Experiments. Yields of Each of the 72 Plots for 1894 and 1895.

|         | Corn.<br>VII.   | Wheat.<br>VI.   | Flax.<br>V.    | Potatoes.<br>IV. | Mangels.<br>III. | Peas.<br>II.    |                 |
|---------|-----------------|-----------------|----------------|------------------|------------------|-----------------|-----------------|
| 12..... | 9.24<br>36.66   | 18.00<br>27.53  | 8.30<br>25.21  | 6.19<br>38.95    | 6.85<br>43.30    | 11.80<br>58.44  | Corn..... 12    |
| 11..... | 9.86<br>29.55   | 11.90<br>20.60  | 8.60<br>21.38  | 20.53<br>34.00   | 5.98<br>35.72    | 12.10<br>33.96  | Wheat..... 11   |
| 10..... | 9.80<br>11.89   | 11.70<br>8.86   | 7.50<br>7.26   | 23.94<br>18.44   | 6.59<br>13.80    | 10.50<br>16.36  | Flax..... 10    |
| 9.....  | 10.55<br>158.88 | 12.90<br>115.55 | 8.70<br>122.21 | 14.34<br>103.33  | 7.00<br>220.55   | 10.00<br>194.21 | Potatoes..... 9 |
| 8.....  | 9.87<br>9.56    | 15.60<br>7.57   | 8.20<br>7.73   | 16.45<br>12.20   | 6.69<br>11.20    | 7.70<br>12.03   | Mangels..... 8  |
| 7.....  | 10.5<br>19.90   | 18.40<br>16.66  | 7.80<br>12.08  | 10.32<br>18.60   | 7.55<br>11.77    | 9.30<br>13.44   | Peas..... 7     |
| 6.....  | 9.87<br>69.90   | 19.50<br>57.29  | 8.30<br>46.97  | 10.21<br>58.44   | 5.52<br>56.15    | 9.20<br>43.54   | Corn..... 6     |
| 5.....  | 10.75<br>33.66  | 19.90<br>30.18  | 9.30<br>25.93  | 17.09<br>32.78   | 7.13<br>28.54    | 8.40<br>22.10   | Wheat..... 5    |
| 4.....  | 11.12<br>14.34  | 16.60<br>14.25  | 8.10<br>8.38   | 27.31<br>13.51   | 5.44<br>9.91     | 9.50<br>11.30   | Flax..... 4     |
| 3.....  | 11.30<br>204.43 | 22.30<br>187.76 | 8.30<br>133.33 | 16.98<br>183.33  | 5.13<br>88.88    | 10.00<br>73.33  | Potatoes..... 3 |
| 2.....  | 7.45<br>10.50   | 22.00<br>11.53  | 8.80<br>10.08  | 13.32<br>14.60   | 4.53<br>9.43     | 8.80<br>8.66    | Mangels..... 2  |
| 1.....  | 8.35<br>32.00   | 25.10<br>23.00  | 8.50<br>26.88  | 17.47<br>28.40   | 5.56<br>16.52    | 6.70<br>17.33   | Peas..... 1     |

Table LXXVIII gives the average yields of the duplicate plots. The yields for the several crops in 1894 in belts running north and south (up and down in the diagram) are in common type, while the yields for 1895 are in bold face type and each crop is shown by the headings at the left to run across the page, or to the east and west, at right angles to the crops for 1894. As the crops are to be again grown on these series in belts running north and south in 1896, the same as in 1894, only partial summaries will be attempted here.

TABLE LXXVIII.—Cross Rotation Experiments. Averages of Duplicate Plots For 1894 and 1895.

|                      | Corn.<br>XII. | Wheat.<br>VI. | Flax.<br>V.   | Potatoes.<br>IV. | Mangels.<br>III. | Peas.<br>II.  |                  |
|----------------------|---------------|---------------|---------------|------------------|------------------|---------------|------------------|
| 6 & 12.....          | 9.56          | 18.75         | 8.30          | 8.20             | 6.18             | 10.50         |                  |
| <b>Corn.....</b>     | <b>52.80</b>  | <b>41.01</b>  | <b>36.34</b>  | <b>48.35</b>     | <b>49.52</b>     | <b>47.48</b>  | <b>6&amp;12</b>  |
| 5 & 11.....          | 10.30         | 15.90         | 8.95          | 18.87            | 6.05             | 10.25         |                  |
| <b>Wheat.....</b>    | <b>29.26</b>  | <b>29.05</b>  | <b>22.19</b>  | <b>33.39</b>     | <b>32.54</b>     | <b>26.12</b>  | <b>5&amp;11</b>  |
| 4 & 10.....          | 10.46         | 14.02         | 7.80          | 25.62            | 6.01             | 10.00         |                  |
| <b>Flax.....</b>     | <b>11.90</b>  | <b>8.36</b>   | <b>8.41</b>   | <b>15.91</b>     | <b>12.14</b>     | <b>13.17</b>  | <b>4&amp;10</b>  |
| 3 & 9.....           | 10.79         | 17.60         | 8.50          | 15.66            | 6.03             | 10.00         |                  |
| <b>Potatoes.....</b> | <b>161.09</b> | <b>154.21</b> | <b>125.75</b> | <b>143.33</b>    | <b>157.22</b>    | <b>127.40</b> | <b>3 &amp; 9</b> |
| 2 & 8.....           | 8.66          | 19.25         | 8.50          | 14.88            | 5.61             | 8.25          |                  |
| <b>Mangels.....</b>  | <b>9.06</b>   | <b>8.92</b>   | <b>8.76</b>   | <b>13.40</b>     | <b>11.43</b>     | <b>15.61</b>  | <b>2 &amp; 8</b> |
| 1 & 7.....           | 6.92          | 17.59         | 8.15          | 13.80            | 6.55             | 8.00          |                  |
| <b>Peas.....</b>     | <b>35.49</b>  | <b>20.16</b>  | <b>19.98</b>  | <b>23.50</b>     | <b>13.35</b>     | <b>18.25</b>  | <b>1 &amp; 7</b> |

NOTE.—The yields for 1895 except in case of the potatoes on series IV, which were nearly ruined by drouth in 1894, are corrected on the basis of the yields of the respective plots in 1894. The average 1895 duplicate yields of each respective plot is divided by that number found by dividing the average yield of each two plots in 1894 into the average of the entire twelve plots of the same crop in 1894, thus lowering or raising the 1895 yields of plots which produced respectively more or less than the average of their series in 1894.

Studying each crop we find that following peas; mangels gave its best yield; corn gave its fourth best yield, and wheat, potatoes and peas gave their next to poorest yields.

Following mangels; no crops gave their best yields, three, corn, wheat and potatoes gave their next to best yields; flax and mangels gave their third best yields and peas gave its poorest yield.

Following potatoes; wheat and flax gave their best yields; mangels and peas gave their second best yield; corn gave its third best, and potatoes gave its fourth best yield.

Following flax; flax and peas gave their next to poorest yields; and corn, wheat, potatoes and mangels gave their poorest yields.

Following wheat; potatoes and peas gave their third best yields; wheat gave its fourth best yield; corn and mangels gave their fifth best yields; and flax its poorest yield.

Following corn; three crops, corn, potatoes and peas gave their best yields; wheat gave its third best yield; and flax and mangels gave their fourth best yields.

The hoed crops, corn, potatoes and mangels had an especially good effect in preparing the land for other crops. Flax, wheat and even the field peas did not prepare the land well for other crops, flax and wheat especially doing poorly after flax and wheat.

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## WEEDS IN OUR FIELDS.

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WILLET M. HAYS.

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### FOX TAIL OR PIGEON GRASS.

While a bulletin of the experiment station does not seem so appropriate a place for the general discussion of the principles to be followed in weed destruction as a hand book for that purpose would be, yet there are a few weeds which are gaining such headway in this state, that the best methods for their destruction need widest circulation. The one weed which in the aggregate does most to sap our soils of the moisture and plant food needed by our crops is Foxtail, commonly called in most sections of the state Pigeon Grass and named by the botanists *Setaria glauca* and *Setaria viridis*, there being two nearly similar species, one with yellowish, the other with greenish awns. It is a close relative of the millets and resembles them in appearance of plant, spike and seeds and in many of its habits of growth. This grass comes into each neighborhood within a few years after the earliest settlement. It rapidly infests every field, the seeds being spread mainly by means of unclean seed grain and in unrotted barnyard manures. It is

simply everywhere and the amount of it on any farm determines the kind and the quality of the farming carried on. It is an annual and a very profuse seeder, the seeds being produced if drouth necessitates, on very short plants. In rather dry climates the seeds turned under to the bottom of the furrow slice will live for a few years, and when the furrow is again inverted will grow. When cut or eaten off it sends out stools which produce seeds. It is strictly an annual, but since its seeds often live for more than a year it cannot be destroyed by one clean summer fallow nor by a clean cultivated crop. There is hardly a crop among which it cannot produce seeds. It germinates a little late in the spring, not earlier than corn, but it will produce seeds even if it does not germinate until after corn is "laid by" in July. Among poor crops of wheat or other small cereal crops, where it ripens about at the same time as the grain, and in the hills and drills of poorly cultivated hoed crops it produces its most abundant and dangerous supplies of seeds. It becomes so abundant in the poorly managed farm as to reduce materially the yield of crops and the value of the land. The man who so rotates and cultivates his crop as to keep this weed at a minimum has few other weeds. Two of our other very worst weeds, lamb's quarter *Chenopodium album* and pigweed *Amaranthus retroflexus*, are kept from doing serious injury by the methods best to employ in combating foxtail. It is important in opening up a new farm or new fields on an old farm to prevent the introduction of this and other weeds, since here an ounce of prevention is worth many pounds of cure. All seeds of grains, grasses, etc., should be most carefully selected or cleaned to prevent the seeding of this pernicious grass. Manure spread on lands free from this and other weed seeds should be rotted by composting or spread only on lands already infested. Doubtless under some conditions this weed is distributed by the seed and the spikes or "heads" being blown across the snow from field to field, and to keep it entirely off the prairie farm under these conditions seems a well nigh hopeless task. We must farm well if we shall be able to keep its injuries at a low point. We must combat this weed as the bulk of most other weeds, with cultivated crops, grass crops and with leafy grain and forage crops so strong and thick as to smother out weeds. We must so arrange the rotation that

the crops which favor the large production of foxtail seeds do not come together but are alternated with other crops among which little or none of it ripens. When we have corn or other cultivated crop it must be cultivated so as to keep ahead of the weeds from the very start so that no weeds are allowed to grow. We must have our lands full of fertility that we may get paying crops, and, secondarily, that they may help to smother out the weeds. Stock help to keep down this and other weeds by making it necessary to grow more pastures, meadows, corn and annual crops for silage and ensilage, and the manure from the stock helps to keep the land rich, so that the crops will grow large and smother the weeds. Sheep are useful in cleaning fields of this weed, as they like not only the young foxtail but the ripe seeds as well.

There are a few special precautions we can follow in fighting foxtail. A great effort should be made to plow all grain stubble as early in the fall as possible. This is named first because there is nothing else we can do which will do so much toward preventing large crops of fox tail from producing seeds. In many cases shallow plowing or disking the stubble, the regular plowing to be done later in the fall or early in the spring, is wise as a matter of economy of labor or of necessity. And burning stubble where it can be done is often wise on weedy land. It is easy to make on the farm the additional part of a load of manure per acre to take the place of any fertility the fire may destroy. In cultivating corn for grain we should plant it in hills that we may cultivate it both ways. The seed bed should always be made fine and we must cultivate the corn with the harrow until it is several inches high and ahead of the weeds. Foxtail among cultivated crops should never be allowed to reach an inch in height, because before this time the plants are very easily killed. By dragging the finely prepared seed bed when the corn is two inches high and again when it is four inches high all the young fox tail is killed. At the first cultivation with the corn cultivator when the stalks are six inches high the cultivator can be set so as to throw a half inch depth of the fine surface soil into the hill under the blades of corn and cover the foxtail without covering the corn. And at each succeeding cultivation a half inch of earth thrown into the hill will keep down the starting foxtail plants. The

cultivation should not be stopped too early. A single horse cultivator run between the rows the middle or latter part of July will insure that very few foxtail plants live to mature seeds. In like manner thorough weed work may be done in the cultivation of potatoes or other crop. Frequent cultivation brings new supplies of weed seeds under conditions where they will germinate. It is wise to clean thoroughly the visiting threshing and corn shredding and threshing machinery before they are set to work on the farm intended to be kept clean. Of only secondary importance is the fact that these methods aimed at foxtail will result, if thoroughly executed, in having the fields clean of nearly all other weeds, especially those troublesome annuals, lambs quarter and pigweed.

### COMMON YELLOW MUSTARD.

*Common Yellow Mustard* (*Brassica sinapistrum*)—Has become widely scattered throughout Minnesota. The constant growth of flax and wheat and other spring grains on our rich lands has given it every opportunity for spreading. Farmers have not been careful in their purchase of seeds from unknown sources, and this has been a most prolific source of spreading this weed. It may be put down as a general principle that farmers should get the seed for their main crop of flax or the small cereals from some neighbor who has fields clean of weeds and who regularly raises large yielding crops of the desired class of seeds. If it is desirable to try new kinds, secure only small quantities of seeds that no large field be infested should they contain weeds and use special care in cleaning. Too often farmers have not cleaned seed grains grown on their own farms but thoughtlessly spread mustard from one to several fields of the farm. Renters and owners of land have not been alert enough upon the first appearance of this plant in their nearly virgin fields, but instead of pulling the first scattering plants, have allowed them to mature and scatter their seeds. In this manner numerous fields are now thickly infested and in some neighborhoods the passer-by may see for mile after mile grain fields colored golden by this pest when in blossom and before the grain has reached its full stature. This weed does not reduce the yields of the crops among which it grows so badly as do many



other weeds. But it puts a bad appearance on the farm to say the least. It makes the man who farms the fields feel that his work is showing him in a bad light.

The owner of the soil realizes that it lessens the selling value of the farm by a few dollars per acre for every acre badly infested and under any pretense at good farming nothing short of cleaning out every plant can be thought of.

Mustard is a spreading annual which grows about two feet tall, when not crowded; has yellow blossoms; and when young it resembles in leaf, stem and root, its relative the radishes, turnips, etc.

Though it is an annual it can stand only a moderate amount of freezing. Its seeds may live for several years when so deeply buried in the furrow slice that they cannot germinate, thus requiring several years for its complete eradication, as these buried seeds when again brought near the surface will germinate.

The seeds are nearly like turnip seeds in appearance. They are produced in large numbers in pods and as the plants ripen with or earlier than most of the grains with which they grow many of the pods open, allowing the seeds to fall to the ground while others are harvested and threshed with the grain. Mustard germinates fairly early in the spring and the earliest plants ripen with or before wheat and oats while plants coming up with late sown flax have ample time to ripen seeds.

The only secret of ridding a field of mustard is to prevent the ripening and spreading of seeds. There is no easy way of doing this. Where the field is thickly infested, pulling is too expensive and the bulk of the mustard seeds already in the ground must be caused to germinate and be killed by a summer fallow, by laying the land down to grass for a few years, pulling when necessary in the grass lay, or best of all by one or more hoed crops. Usually this can be done without much cost. The longer the soil is used for crops among which the mustard is not allowed to seed, the less will be the expense of the pulling the first year that small grain is grown. Cultivated crops or summer fallow, twice plowed, or several times cultivated, induces many seeds to germinate by repeatedly bringing new supplies of them under conditions favorable to germination. The cultivation should be so thoroughly done that no

mustard plants be allowed to ripen, and to make sure of this, the cultivated crop should be gone over once or oftener to pull or destroy with the hoe any plants not killed by the cultivator. It may be necessary to go over the grass crop or the summer fallow land to destroy scattering plants which are producing seeds. Many fields have been cleaned of mustard even where constantly used for wheat. Mustard may be kept from seeding among grain crops, often without any very great expense, by pulling up the young mustard plants. The labor is considerable and the vigilance must be most constant that the pulling be at the right time and very complete. The pulling should be begun at or shortly after the time the earliest plants are showing their yellow blossoms among the yet small grain. During this stage of their development the plants may be thrown on the ground, using care that none of them have sufficient earth in contact with their roots to enable them, should there be moist weather, to continue to grow. Some pods on each plant will ripen while others are just coming into blossom so that unless constant vigilance is exercised seeds may be deposited in the soil before the uninitiated suspects their maturity. The pulling should be repeated every week so long as the plants can be seen among the rapidly rising grain, each time making the pulling as complete as is possible. Where the farm is large and extra help is required the pullers may be worked in gangs. When at North Dakota experiment station, Fargo, 1892 and 1893, the writer successfully employed small boys to do the pulling, paying them twenty-five to seventy-five cents per day. A foreman followed behind to see that each boy did his work well. The boys formed a line of march, each one covering a strip ten to fifteen feet wide across the field. During the last time over the field before the grain was so tall we could not find the mustard, some plants were found on which seed pods were already formed. As moist weather might develop some of these seeds so that they would grow, it was thought wise not to leave them on the field and a wagon followed the pullers, hauling all the weeds to the compost heap. This process needs to be repeated for several years if the spring grain is continuously grown, or where spring grain is grown in alternation with hoed crops in which likewise careful work must be done to prevent any mustard

from ripening. The cost of pulling is fairly serious the first year but becomes gradually lighter annually, and if thoroughly done the land will be clean in several years. Other means, as the growing of pastures from annual crops, growing soilage crops which will be plowed before mustard ripens may also be used instead of the fallow or the cultivated crop.

### WILD OATS.

*Wild Oats (Avena fatua)* stands with the wild mustard as one of the troublesome annual weeds which we often get on Minnesota farms, and it is wise economy to eradicate every plant. The term wild oats is often applied to porcupine grass (*Stipia pennata*) the seeds of which, with their long awns, often are troublesome in getting into the wool of sheep or even giving trouble to other animals. The wild oat is an annual plant and in appearance when growing is almost identical with the white tame oats which have a spreading panicle and white chaff. Before the plants head out no difference can be discerned and but little after the panicle appears until the ripening stage occurs. It matures its seeds earlier, however, than most varieties of common oats and what makes it troublesome to eradicate is its habit of dropping its seeds as soon as the plant ripens and before the small grain crop with which it grows is ripe, thus supplying the soil with seeds for a volunteer crop the next season. This habit of shedding seeds on the soil which will live to the next season, and sometimes for a few years, makes it a rather difficult plant to deal with where spring grains ripening a little later than the wild oats are grown often or continuously in the rotation. In cultivated crops, as corn, potatoes, etc., the cultivation as ordinarily done permits occasional plants to ripen their seeds unless particular care is used to destroy every plant.

Wild oats have a few peculiarities by which they may surely be determined among common oats. The berry is much more slender than in case of good varieties of tame oats. The glume on the kernel is rather thick and usually somewhat dark, very similar in color to some varieties of tame oats, but around the lower end there is a distinct fringe of hairs about one-twentieth of an inch in length. The awn from the flowering glume

springs from the middle of the back of the berry and, as a rule, is longer and stronger than on tame varieties. This awn has the peculiar power of twisting near its base when alternately dried and moistened, and will move the berry about on the table and aids in burying it in the soil.

The plant when nearly ripe is usually taller than the oats, wheat or barley with which it grows, and ripening earlier the light color of the large spreading panicles may easily be observed by the experienced eye. This oat has a somewhat greater recuperative power when cut or eaten off during the growing period, than common oats. Plants cut off at any time before quite ripe may throw out stools and produce new panicles full of seeds ere the frosts of autumn kill the plant. And merely cutting the plant off does not always kill it. This weed has been most distributed in seed of cereal grains, sometimes by unrotted manure, and doubtless the wind sometimes carries the seeds across the snow on our prairies, while the threshing machine is not an uncommon means of bringing them to our fields. It is very much doubted if this seed ever germinates after having passed through the digestive tract of cattle or other animals.

The simple principle of inducing all seeds to germinate and then destroying all plants before they produce seeds, underlies all means of combatting this as well as other annual weeds, which have once gained a hold in our fields. Every farmer should learn how to discover this oat among tame oats or other grains and should discard all seed grain which contains seeds of wild oats. The illustration herewith shows several seeds of tame oats of common varieties and several seeds of this wild troublesome species.

*The Methods of Eradication of Wild Oats* are comparatively simple. If there are but small patches or scattering plants and it is desired to grow spring grains, the field can be carefully paroled every few days just as the wild oats are ripening. When the wild oats begin to ripen the experienced eye can detect the white headed, early oat plants and they may be removed by pulling or by cutting them off, and carrying them outside the field, where they should be burned. If the plants appear rather thickly in spots the crop should be mown in these places and the whole removed while yet green; if allowed



Fig. 76.—Panicle of Wild Oats.

to partially dry some of the nearly ripe wild oat seeds will shatter out and reseed the soil. Wild oats materially decrease the crop of small grain or the cultivated crop among which they grow in quantity. Where thickly infesting a field or where such crops are profitable, crops should be grown among which wild oats will not be allowed to ripen. An early variety of barley or winter rye will ripen so early that it may be harvested before the wild oats are mature enough to shatter out, and this often proves a means of preventing them from seeding for the year. Millet and some other annual forage crops which can be mown before the wild oats are matured, are also useful to prevent this weed from ripening its seeds. The land should be fall-plowed early that none of the wild oat plants cut off early may be allowed to send up flowering culms by stooling out at the base of the plant. Cultivated crops like, corn, potatoes, etc., serve a most excellent purpose if the cultivation be so thorough that no wild oats be allowed to ripen, as the repeated cultivations insure that all seeds in the upper part of the furrow slice will at some time during the season be so placed as to get in that condition of moisture and warmth that will cause it to germinate. Since some of the seeds will remain alive under the furrow slice for at least a few years, and probably for many years in series of dry seasons, it is usually necessary to keep up methods preventing the seeding of every plant from two to several years. In the eastern, moister part of the state, two years is usually sufficient and sometimes one year's thorough work will eradicate the pest. It is a noticeable fact that in stock and hay raising sections of the state the wild oat is disappearing, and where these two industries combine with the raising of barley as the main cereal crop the fear of the pest is small.

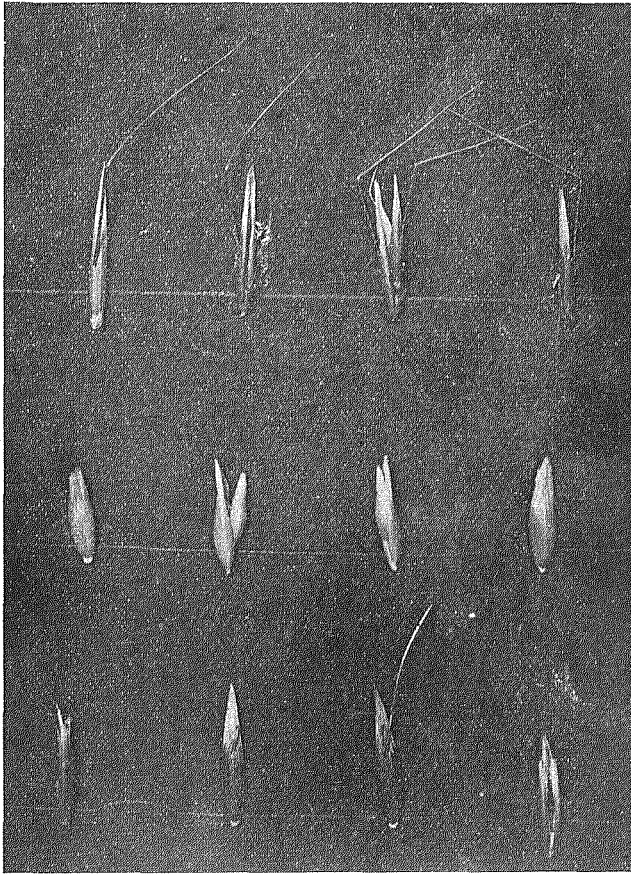


Fig. 77.—Four kernels wild oats in upper row; four kernels plump white oats in middle row; four kernels black tame oats in lower row.

# TILLAGE EXPERIMENTS AT COTEAU FARM.

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WILLET M. HAYS.

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In 1895 preliminary experiments were outlined by the writer and Mr. T. A. Hoverstad, then in charge at Coteau Farm, looking to extensive experiments in the southwestern part of the state to determine how best to plow, prepare and till the soil to conserve soil moisture, and thus produce better crops under drouthy conditions. Four series of twenty two one-tenth acre plots each, eighty-eight plots in all, were planted to wheat and oats to test different methods of treatment of the soil. Part of the land was fall plowed and part spring plowed. Numerous plots were plowed  $3\frac{1}{2}$  inches deep, others were plowed  $5\frac{1}{2}$  inches deep, and still others  $7\frac{1}{2}$  inches deep, while other plots were subsoiled. Some plots were manured with coarse and some with rotted manure, while other plots were unmanured. Some of the grain was sowed broadcast, some seeded with a shoe chain drill and some with a shoe press drill. A few plots were planted in drills far enough apart to be cultivated, that this method might be compared with plots drilled six inches apart in the ordinary way. Numerous plots were rolled with Mr. Campbell's sub-surface packer to compare this with plots not so treated. On some plots the stubble was plowed under, while on others the stubble was burned, and part of this was plowed and part simply disked before seeding. A number of plots were harrowed to compare harrowing before seeding and also harrowing after the plants were up, with no harrowing. Different kinds of seeding implements were employed and other comparisons not here mentioned on account of uneven soil, were attempted.

The land did not prove as uniform as we had thought, and many of the comparisons have been deemed not worthy of publication. In the following pages, however, are numerous records of plots which are comparable, and where there are numerous duplications, eliminating individual plot differences, which records were thought too valuable to throw away. They are not here published as very satisfactory results, but if corroborated by future trials may be given weight in settling the questions involved. Owing to the somewhat unsatisfactory



character of the land no summaries or deductions are here offered, simply the bare facts are displayed in the tables and in the explanatory language. The outline for the tillage experiments at Coteau Farm in 1896 include fewer methods of treatment, more duplications of each plot, and thorough control determinations of the soil moisture. For this purpose a small building has been equipped with drying oven, scales, sampling devices and other equipment for making many determinations of soil moisture. Enough soil moisture control work was done in 1895 for Mr. Wm. G. Smith who has charge of the details of this work, to thoroughly get in hand the methods of rapidly taking the samples and making the moisture determinations.

FALL PLOWING VS. SPRING PLOWING OF STUBBLE LAND FOR WHEAT.

Table LXXIX gives the yields of twelve plots sowed to wheat in 1895 at Coteau Farm, six of which were fall plowed and six plowed at similar depths in the spring. The land is a medium to heavy soil of mixed clay, sand and gravel, and it has a rather dense subsoil. One plot plowed in the fall at a depth of  $3\frac{1}{2}$  inches was planted with the press drill, and one with the shoe chain drill; in like manner the plots spring plowed at this depth were planted with the press and chain shoe drills. And the plots plowed  $5\frac{1}{2}$  inches and  $7\frac{1}{2}$  inches deep were in like manner planted with the press and chain shoe drills. In all instances the fall plowed land yielded several bushels more per acre than the plots sown with the same machine and at the same depth on spring plowed land. The average yield on the six plots on the fall plowed land was 28.4 bushels per acre, while the average on the six spring plowed plots was only 22 8 bushels.

TABLE LXXIX.—Fall Plowing vs. Spring Plowing Stubble Land for Wheat.

|                  | Fall Plowed. |          |                       |                       |                       | Spring Plowed.         |         |          |                       |                       |                       |                        |
|------------------|--------------|----------|-----------------------|-----------------------|-----------------------|------------------------|---------|----------|-----------------------|-----------------------|-----------------------|------------------------|
|                  | Series.      | Plot.    | $3\frac{1}{2}$<br>in. | $5\frac{1}{2}$<br>in. | $7\frac{1}{2}$<br>in. | Average of<br>averages | Series. | Plot.    | $3\frac{1}{2}$<br>in. | $5\frac{1}{2}$<br>in. | $7\frac{1}{2}$<br>in. | Average of<br>averages |
| Press drill..... | VI           | 29-21-20 | 27.2                  | 26.1                  | .....                 | .....                  | IV      | 21-20-19 | 27.1                  | 23.1                  | .....                 | .....                  |
| Chain drill..... | VI           | 19-18-17 | 30.5                  | 28.6                  | 29.2                  | .....                  | IV      | 18-17-16 | 21.7                  | 21.1                  | 21.1                  | .....                  |
| .....            |              |          | 28.8                  | 27.3                  | 29.2                  | 28.3                   |         |          | 24.4                  | 22.1                  | 21.1                  | 22.8                   |

## MANURED VS. UNMANURED LAND FOR WHEAT.

In Table LXXX are given the results at Coteau Farm, on fall plowed land considerably worn, of five comparisons of manuring with rotted and unrotted stable manure versus not manuring. In five out of seven cases the unmanured plot yielded more than the plot which was manured but otherwise treated in the same way, and the average of the seven plots not manured was 20.8 bushels per acre, while the average of those manured was only 19.9 bushels. This does not necessarily show that the land does not need manure for wheat but it may be that the manure needs to be applied to a previous crop. The bad effects of the manure in making a rank growth of straw at the expense of the grain may more than overbalance the good effect of the food supplied by the manure together with its effect on making the soil moister on account of the greater amount of humus which helps to conserve soil moisture.

TABLE LXXX.—Manured vs. Unmanured Land for Wheat.

| Series. |                           | Manured. |        |        |        | Not Manured. |       |        |        |        |
|---------|---------------------------|----------|--------|--------|--------|--------------|-------|--------|--------|--------|
|         |                           | Plot.    | 3½ in. | 5½ in. | 7½ in. | Series       | Plot. | 3½ in. | 5½ in. | 7½ in. |
|         | Rotted manure—            |          |        |        |        |              |       |        |        |        |
| IV...   | { Press drill.....        | 6-4      | .....  | 18.5   | 19.3   | IV           | 20-19 | .....  | 23.1   | 26.0   |
| IV...   | { Press drill S. S. P ..  | 5-3      | .....  | 20.4   | 22.4   | IV           | 11-10 | .....  | 20.8   | 16.1   |
| VI...   | { Press drill.....        | .....    | .....  | 16.2   | .....  | V            | 6     | .....  | 19.8   | .....  |
|         | Averages.....             | .....    | .....  | 18.4   | 20.8   | .....        | ..... | .....  | 21.2   | 21.1   |
|         | Coarse manure—            |          |        |        |        |              |       |        |        |        |
| IV...   | { Press drill.....        | 2        | .....  | .....  | 20.6   | IV           | 13    | .....  | .....  | 22.5   |
| IV...   | { Press drill S. S. P.... | 1        | .....  | .....  | 22.3   | VI           | 8-9   | .....  | .....  | 17.1   |
|         | Averages.....             | .....    | .....  | .....  | 21.4   | .....        | ..... | .....  | .....  | 19.8   |
|         | Average of averages..     | .....    | .....  | .....  | 19.9   | .....        | ..... | .....  | .....  | 20.8   |

NOTE—Wherever S. S. P. means that the land was subsurface packed by means of Campbell's subsurface packer, which packs the lower half of the furrow slice; manufactured by the Sioux City Iron Works, Sioux City, Iowa.

## SUBSOILED VS. NOT SUBSOILED LAND FOR WHEAT.

In Table LXXXI are given the results of three comparisons of plots subsoiled in spring for wheat, as compared with plots not subsoiled; and one comparison with oats. The land was plowed 5½ inches deep and subsoiled 6 inches deeper. The figures show that the subsoiled land did not produce as well as that not subsoiled.

TABLE LXXXI.—Subsoiled vs. Not Subsoiled Land for Wheat.

| Series. |                   | Subsoiled. |        |        |        | Series. | Not Subsoiled. |        |        |        |
|---------|-------------------|------------|--------|--------|--------|---------|----------------|--------|--------|--------|
|         |                   | Plot.      | 3½ in. | 5½ in. | 7½ in. |         | Plot.          | 3½ in. | 5½ in. | 7½ in. |
| VII.    | Wheat—            |            |        |        |        |         |                |        |        |        |
|         | Press drill ..... | 11         | .....  | 18.9   | .....  | IV      | 20             | .....  | 23.1   | .....  |
| VII.    | Chain drill.....  | 10         | .....  | 20.4   | .....  | IV      | 17             | .....  | 21.1   | .....  |
| VII.    | Broadcast.....    | 9          | .....  | 18.0   | .....  | VI      | 15             | .....  | 17.1   | .....  |
|         | Averages.....     |            |        | 19.1   |        |         |                |        | 20.4   |        |
| V....   | Oats—             |            |        |        |        |         |                |        |        |        |
|         | Broadcast.....    | 2-2-1      | .....  | 33.3   | .....  | V       | 4              | .....  | 42.8   | .....  |

SOWING WHEAT WITH SHOE PRESS AND CHAIN DRILLS AND WITH BROADCAST SEEDER.

Table LXXXII gives six comparisons among shoe chain and press drills and broadcast seeders and three among the broadcast and shoe chain drills alone. The land was not as uniform as we had believed, but the comparison is so emphatic against broadcasting on fall plowed land and in favor of the shoe drill that we deem the figures eminently worthy of publication. Common practice and other trials would indicate that in dry years, especially if the soil be dry in early spring, the shoe press drill would be better in the southwestern part of the state, but in this fairly moist season the shoe chain drill gave better yields than the press drill.

TABLE LXXXII.—Shoe Press vs. Shoe Chain Drills vs. Broadcast Seeders.

| INCHES.        | Plot.    | Press drill. | Chain drill. | Broadcast. | Broadcast & S. S. packed. | Chain drill & S. S. packed. |
|----------------|----------|--------------|--------------|------------|---------------------------|-----------------------------|
| 3½ .....       | 21-13-9  | IV<br>27.1   | IV<br>21.7   | IV<br>12.7 | .....                     | .....                       |
| 5½ .....       | 20-17-8  | 23.1         | 21.1         | 15.0       | .....                     | .....                       |
| 7½ .....       | 19-16-7  | 26.1         | 21.1         | 15.6       | .....                     | .....                       |
| 3½ .....       | 12-10-16 | 21.9         | 30.5         | 17.9       | .....                     | .....                       |
| 5½ .....       | 11-18-15 | 20.8         | 23.6         | 17.1       | .....                     | .....                       |
| 7½ .....       | 10-17-14 | 16.1         | 29.2         | 18.5       | .....                     | .....                       |
| 3½ .....       | 13-10    | .....        | .....        | .....      | VI<br>18.2                | VI<br>21.0                  |
| 5½ .....       | 12.9     | .....        | .....        | .....      | 18.7                      | 14.4                        |
| 7½ .....       | 14.8     | .....        | .....        | .....      | 18.7                      | 17.1                        |
| Averages ..... | .....    | 22.5         | 25.4         | 16.1       | 18.5                      | 17.5                        |

## CULTIVATING DRILLED WHEAT VS. COMMON DRILLING.

Table LXXXIII gives a number of comparisons of plots of wheat planted 21 and 28 inches apart on land fall plowed 5½ inches deep and cultivated, in comparison with plots drilled in the ordinary way with the shoe drills six and seven inches apart and not cultivated. The average yield of ten cultivated plots is only 16.4 bushels of wheat per acre, while that sown in the ordinary way yielded 23 bushels. The cultivated wheat was not a grade better than that planted in the ordinary way, and the cost of cultivation in practical field culture would be considerable.

TABLE LXXXIII.—Cultivating Drilled Wheat vs. The Common Drill Method.

|                  | Cultivated Between Drills. |        |                           |        | Not Cultivated. |       |                    |
|------------------|----------------------------|--------|---------------------------|--------|-----------------|-------|--------------------|
|                  | Series.                    | Plot.  | Distance apart of drills. |        | Series.         | Plot. | Drills 6 in. apart |
|                  |                            |        | 21 in.                    | 28 in. |                 |       |                    |
| Press drill..... | IV                         | 22     | 20.5                      | .....  | IV              | 20    | 23.1               |
| Press drill..... | V                          | 22-8-7 | 13.7                      | 19.4   | V               | 6     | 19.8               |
| Press drill..... |                            |        | 14.1                      |        |                 |       |                    |
| Press drill..... | VII                        | 22-21  | 20.4                      | .....  | VI              | 21    | 26.1               |
| Press drill..... | VII                        | 2-1    | 11.3                      | 12.8   | .....           | ..... | .....              |
| Press drill..... |                            |        | 12.8                      |        |                 |       |                    |
| Averages.....    | .....                      | .....  | 17.2                      | 15.6   | .....           | ..... | 23.0               |

## THE DEPTH TO PLOW FOR WHEAT.

Tables LXXXIV and LXXXV give numerous comparisons between plots of stubble land plowed 3½, 5½ and 7½ inches deep, both in fall and in spring. The results show comparatively little difference in this respect for this one year's trial. The shallowest plowing proved slightly best, while that plowed deepest came next. This was a moist season and the wheat easily got the mastery over the weeds, and the results may show very different with a dry season, or even for the average season.

TABLE LXXXIV.—The Depth to Plow for Wheat.

| Series. | Plots.                                   | Depth of Plowing. |        |        |      |
|---------|--|-------------------|--------|--------|------|
|         |  | 3½ in.            | 5½ in. | 7½ in. |      |
| IV...   | { Spring Plowing—                        |                   |        |        |      |
|         | Press drill.....                         | 21-20-19          | 27.1   | 23.1   | 26.0 |
|         | Chain drill.....                         | 18-17-16          | 21.7   | 21.1   | 21.1 |
|         | Press drill.....                         | 12-11-10          | 21.9   | 20.8   | 16.1 |
|         | Broadcast.....                           | 9-8-7             | 12.3   | 15.0   | 15.6 |
|         | Averages.....                            |                   | 20.7   | 20.0   | 19.7 |
| VI...   | { Fall Plowing—                          |                   |        |        |      |
|         | Chain drill.....                         | 19-18-17          | 30.5   | 28.6   | 29.2 |
|         | Broadcast.....                           | 16-15-14          | 17.9   | 17.1   | 18.5 |
|         | Broadcast and S. S. packed.....          | 13-12-11          | 18.2   | 18.7   | 18.7 |
|         | Chain drill and S. S. packed.....        | 10-9-8            | 21.0   | 14.0   | 17.1 |
|         | Averages.....                            |                   | 21.9   | 19.6   | 20.9 |
|         | Averages of spring and fall plowing..... |                   | 21.3   | 19.8   | 20.3 |

TABLE LXXXV.—Depth to Plow for Wheat.

| Series. | Plots.                                      | Depth of Plowing. |        |      |
|---------|---|-------------------|--------|------|
|         |   | 5½ in.            | 7½ in. |      |
| VI...   | Chain drill, S. S. packed.....              | 9-8               | 14.4   | 17.1 |
| VI...   | Press drill, S. S. packed.....              | 7-6               | 18.2   | 18.1 |
| VII     | Press drill, stubble-burned and plowed..... | 7-6               | 19.9   | 17.6 |
|         | Averages.....                               |                   | 17.5   | 17.6 |

## BURNING AND PLOWING STUBBLE VS. BURNING AND DISKING.

Table LXXXVI gives the results of two plots on which the stubble was burned before spring plowing as compared with four plots on which the stubble was burned and the ground was disked instead of plowed before sowing with a press drill. The disking proved equally as good as the plowing, though probably in a dry year, or in a year with a dry spring season, the results would have been very different.

TABLE LXXXVI.—Burning and Plowing Stubble vs. Burning and Disking.

| Series. | Burning and Plowing. | Burning and Disking. |        |      |
|---------|----------------------|----------------------|--------|------|
|         |                      | Series.              | Plots. |      |
| VII.    | Press drill.....     | VII                  | 3      | 19.9 |
|         | .....                |                      | 4      | 17.8 |
|         | .....                |                      | 5      | 18.0 |
|         | .....                |                      | 8      | 19.3 |
|         | Average.....         |                      | .....  | 18.7 |

## METEOROLOGICAL RECORD.

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The National Department of Agriculture has inaugurated a Minnesota Section of the Weather and Crop Service with headquarters at Minneapolis. Mr. Edward A. Beals, a trained weather observer and reporter, is in charge, and upon request has furnished the tabular records given in Tables LXXXVII to LXXXX inclusive. The Minnesota weather service is being rapidly improved, and the figures here presented are valuable. The total water falling in the form of rain and snow at forty-five points in the state are given for each month and for the entire year of 1895 in Table LXXXVII. And in Table LXXXVIII the average annual precipitation is given at twenty-seven of these places from which Mr. Beals has been able to secure records of five or more years. The collection and the compilation of these valuable records represents considerable labor and the thanks of the station are due Mr. Beals.

In table LXXXIX are given the mean temperatures at forty-one stations during each month of 1895, and the mean average temperature for the entire year. In Table LXXXX are given the average or normal mean temperatures, both monthly and annual, for twenty-eight stations in the state.

It will be observed, by referring to the left hand column of Tables LXXXVIII and LXXXX, that the averages, or normals, are made up from records running all the way from five to thirty-four years. If we had complete records for a period of one century, or even for half that length of time, we would now be far better able to discuss numerous questions affected by climate. The state may be assuming a grave responsibility in allowing the forests to be destroyed, and lakes to be drained, without in some way taking steps to keep up our forest and water surface areas, and thus keep our fair state supplied with more atmospheric moisture. The data already in hand is valuable, and more should be obtained. Local observers are performing free a valuable public service. The further data recording the degree of moisture in the air would also be valuable.



