UNIVERSITY OF MINNESOTA.

Agricultural Experiment Station.

BULLETIN No. 50.

AGRICULTURAL DIVISION.

DECEMBER, 1896.

PROGRESS AT THE SEVERAL EXPERIMENT FARMS IN 1896. BEANS, VARIETY TESTS.—BARLEY, VARIETY TESTS.—CORN, VARIETY TESTS.—OATS, VARIETY TESTS.—WHEAT, VARIETY TESTS.—WHEAT, SMALLEST VS. LARGEST, VS. HARDEST KERNELS FOR SEED.—ROTATION OF CROPS.—CROSS ROTATION EXPERIMENTS.—ROOT CROPS, VARIETY TESTS.

ST. ANTHONY PARK, RAMSEY COUNTY, MINNESOTA.

EAGLE PRINTING CO., PRINTERS, DELANO.

University of Minnesota.

BOARD OF REGENTS.

	Term Expires.
The HON. JOHN S. PILLSBURY, MINNEAPOLIS. -	*Regent for Life*
The HON. DAVID M. CLOUGH, MINNEAPOLIS. - -	*Ex-Officio*
The Governor of the State.	
CYRUS NORTHROP, LL. D., MINNEAPOLIS. - -	*Ex-Officio*
The President of the University.	
The HON. W. W. PENDERGAST, M. A., HUTCHINSON. -	*Ex-Officio*
The State Superintendent of Public Instruction.	
The HON. L. S. SWENSON, ALBERT LEA. - - - -	1897
The HON. WM. M. LIGGETT, ST. ANTHONY PARK. - -	1897
The HON. JOEL P. HEATWOLE, NORTHFIELD. - - -	1897
The HON. GREENLEAF CLARK, M. A., ST. PAUL. - -	1898
The HON. CUSHMAN K. DAVIS, M. A., ST. PAUL. - -	1898
The HON. STEPHEN MAHONEY, B. A., MINNEAPOLIS. -	1901
The HON. S. M. OWEN, MINNEAPOLIS. - - - - - -	1901
The HON. ALPHONSO BARTO, ST. CLOUD. - - -	1902
*——— ——— ——— - - - - - - - -	1902

*Vacant.

THE AGRICULTURAL COMMITTEE.

The HON. WILLIAM M. LIGGETT, Chairman.
The HON. J. S. PILLSBURY.
The HON. S. M. OWEN.
The HON. W. W. PENDERGAST.
The HON. ALPHONSO BARTO.

OFFICERS OF THE STATION:

WM. M. LIGGETT - - - - - - - - - -	Director.
WILLET M. HAYS, M. Agr., -	Vice Chairman and Agriculturist.
SAMUEL B. GREEN, B. S. - - - - - -	Horticulturist.
OTTO LUGGER, Ph. D., - -	Entomologist and Botanist.
HARRY SNYDER, B. S., - - - - - - - -	Chemist.
T. L. HÆCKER, - - - - - - - - -	Dairy Husbandry.
M. H. REYNOLDS, M. D., V. M., - - - - -	Veterinarian.
THOS. SHAW, - - - - - - - -	Animal Husbandry.
T. A. HOVERSTAD, B. Agr., - -	Asst. in Agr., Crookston.
WARREN W. PENDERGAST, B. Agr.,	Asst. in Agr., Grand Rapids.
ANDREW BOSS, - - - - - -	Asst. in Agr., Univ. Farm.
R. S. MACKINTOSH, - - - -	Asst. in Hort., Univ. Farm.
J. A. VYE, - - - - - - - - - - - -	Secretary.

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

EXPERIMENTS IN THE DIVISION OF AGRICULTURE.

WILLET M. HAYS, T. A. HOVERSTAD, WARREN W. PENDERGAST, ANDREW BOSS.

PROGRESS AT THE SEVERAL EXPERIMENT FARMS IN 1896.

The climatic conditions in Minnesota in 1896 were favorable for good crops of forage and grain throughout the larger part of the state. In the Red River Valley counties, however, the rainfall in April, May and early June was far in excess of that ever before experienced during the seeding season and in spite of the fact that the drainage in this flat area of the state had been materially improved by large ditches constructed by funds in part supplied by the state, and by many branch and roadside ditches made by the counties, townships and farmers, it was impossible to plant more than a small percentage of the anticipated crop area and much of the wheat and other crops planted yielded only a partial crop. The yields of corn fodder and other annual forage and of root crops were generally good excepting in the northwestern counties above mentioned. Hay crops and pasturage, both tame and wild, generally yielded largely, the year previous having been fairly moist a good stand of tame grasses and clovers had resulted. Tame pasture and meadow crops sown in 1896 generally went into the winter with promise of making a good stand in 1897.

On University Farm the field crop work was in large part the continuance of work previously begun, some lines of which will not be completed for publication until future years. Yields generally were good and the results, in the main, normal for the calculation of experimental results. Prominent among the lines of work are variety tests and the

breeding and propagating of varieties of grain, forage and root crops, rotation experiments, pasturage experiments, tillage and the harvesting and storage of crops. The field crop work under the immediate supervision of Mr. Andrew Boss aroused not a little of interest among the many visitors at University Farm during the season. Our policy is to keep all those fields used for experiments in grain and forage crops only average in fertility, that results may be such that they will be applicable to good average farm conditions throughout the state. For some crops, like roots, which require a large amount of hand labor per acre, we shall hereafter make certain series of plots richer in humus and plant food by heavier dressings with barn yard manure, while the remainder of the farm is kept medium in fertility. Since the growth of weeds cause the plots to be uneven in productive capacity, thus causing error in plot experiments, we are trying to reduce the growth of weeds to a minimum on all lands used for experimental purposes, except in the few cases where weeds present one of the problems of the experiment, as in rotation experiments.

Northwest Farm, Crookston, came into the possession of the Experiment Station in the summer of 1895, too late for planting crops that season. This farm consists of 450 acres of good land. Preparatory to beginning active work in 1896 two hundred acres were broken in 1895, a system of surface ditches was begun, a barn and dwelling were erected, and horses and machinery were purchased. The almost daily rains during the spring of 1896 prevented planting crops on the clay lands of this flat farm until nearly the middle of June and the few crops planted after that date made but little growth. Some crops of tame grasses produced an excellent stand for next season and the two hundred fifty acres of native meadows and pastures yielded an abundant crop. A number of new forest plantation plots and numerous vegetables and small fruits made fair growth though planted very late. A small herd of cattle, mainly shorthorns, was purchased and was used in pasture experiments and a small lot of hogs was raised. During the autumn a car load each of steers and of stock sheep were

pastured while in transit from Montana to be fed under experiments by the division of animal husbandry at University Farm. Pastures were fenced, a few miles of roads were constructed and the drainage of the entire farm was well begun. The absence of crops on most of the land broken the previous year made it possible to thoroughly prepare the soil by summer fallowing and fall plowing for crops in 1897. The forestry division of the Department of Agriculture at Washington has undertaken to supplement the prairie forestry work of the Experiment Station on this farm with a large number of forestry plantations and in this manner make of this, one of the forestry experiment stations of the Department of Agriculture. The lines of experimentation in field agriculture planned for the Northwest Farm include the testing of varieties of crops suited to that portion of the state, the propagation in quantity of standard or new varieties of crops and the testing of different rotations of crops for the Red River Valley. Experiments in methods of preparing the land and of planting and cultivating crops under the peculiar conditions of soil and climate in the Red River Valley will be carried on and some stock will be used in the pasturage experiments with grasses, clovers, and also with annual crops used for pasturage. Besides the experimental work the farm will in part be used as a demonstration farm, upon which to display the best methods of practice with staple crops and with live stock. Mr. T. A. Hoverstad has immediate charge of the farm operations, the road building, the drainage, the experiments and other work of North East Farm.

Northeast Farm, Grand Rapids, was acquired by the Experiment Station April 16, 1896. The farm consists of 453 acres, only about sixty acres of which was under cultivation at the time it was deeded to the University. This land, however, having raised potatoes the two or three years since it was cleared and broken was in fine condition and was planted to a variety of crops in experiments and for grain and forage for stock food, and roots and vegetables for sale and for use on the farm. Though the spring opened up very late the climatic conditions were on the whole fav-

orable and good crops were secured. About fifty acres more were cleared during this season, and we now have under cultivation sandy loam, clay and peaty lands typical of the better classes of lands of the great area of the state known as the forest region. Sandy land and stony land suited only to forest and grass crops are also found on the farm. No results are as yet ready for publication though many things were learned as to the treatment of the different soils and the crops they will best produce. The fields have been put in better condition, drains made, roads constructed, fences erected, buildings improved and the farm is already assuming the attractive appearance which its natural features make possible. Plans are being perfected for making a topographical and descriptive survey of this entire farm, preparatory to forestry and field experiments. The division of forestry of the United States Department of Agriculture has arranged to conduct experiments here as well as at Northwest Farm and within the next year the plans for this work will be formed. Mr. Warren W. Pendergast has immediate charge of Northeast Farm and the experiments there undertaken.

On Coteau Farm, where experiments have been under way for three years, on the homestead of O. C. Gregg, superintendent of Farmers' Institutes, the crops were fair and progress was made in the experiments in hand. The experiments in the methods of preparation of the soil, in methods of planting and in intercultural tillage were carried forward. Progress was made in the experiments with pasture and meadow grasses and with making pastures for cattle by sowing annual crops. Mr. Wm. G. Smith is in charge of the special experiment work at Coteau Farm.

BEANS—VARIETY TESTS.

Thirteen varieties of beans were grown at University Farm in 1895 and again in 1896. Table XXX gives the results for each year, also the average yields for both years.

TABLE XXX.—Beans—Variety Tests.

Univ. No.	VARIETY.	1896. Days Maturing.	1896. % Stand of Plants.	1896. Color.	Yield per Acre 1895.	Yield per Acre 1896.	Average Yield.	Univ. No.
1	Boston Pea	95	90	White	20.3	7.7	14.0	1
2	Early White Marrow	95	90	"	19.3	8.3	13.3	2
3	Small Boston Pea	95	90	"	17.6	17.0	17.3	3
4	Snow Flake	95	90	"	16.3	15.3	15.8	4
5	Early White Navy	95	90	"	20.6	16.6	18.6	5
6	Salzer's White Wonder	95	90	"	21.6	17.3	19.5	6
7	Early Manley	95	80	"	19.6	8.3	13.5	7
8	Burlingame Medium	91	95	"	18.3	18.3	18.3	8
9	Swede	95	90	Br'n	14.0	14.0	14.0	9
10	Choice Marrow	99	75	White	13.3	7.7	10.5	10
11	Choice Navy	97	95	"	20.0	22.0	21.0	11
12	Choice Medium	97	95	"	13.3	26.0	19.6	12
13	Improved Tree	97	95	"	16.6	22.3	19.4	13

BARLEY—VARIETY TESTS.

In 1896 seventeen varieties of barley were grown at University Farm and eleven varieties at Northeast Farm. In Table XXX are given the yields of eleven which have been selected as the best of thirty-nine varieties collected prior to 1894. These yields were obtained at University Farm in 1894, 1895 and 1896, and at Coteau Farm in 1895. In another year the tests at University Farm, and at Northeast and Northwest Farms, will enable us to determine the few best varieties to propagate in large enough quantities to disseminate to the farmers in the several sections of the state. Yield, ability of the straw to stand erect on rich land, weight per bushel of grain, and feeding and malting qualities are the points considered in comparing

TABLE XXXI.—Barley—Variety tests—11 Best Out of 30 Kinds.

Univ. No.	VARIETY.	No. Rows of Kernels.	Grade.	Weight per Bushel.	Days Maturing.	Height in Inches.	Crop of 1896.							Average of Four Yields, University Farm, 1894, '95, '96; Coteau, 1895.	Univ. No.
							Weight per Bushel.	Days Maturing.	Height in Inches.	Per cent Standing Up.	Grade.	Yield per Acre. Straw.	Yield per Acre. Grain.		
2	Duckbill	2	93	47	84	35	50	85	39	95	90	1.5	48.7	36.9	2
4	Salzers	2	87	48	84	30	49	85	35	80	85	1.8	60.0	42.1	4
6	Manshury	6	82	46	80	33	50	84	38	85	84	1.9	52.5	42.4	6
7	Champion of Vermont	2	83	47	80	32	47	84	36	80	80	1.3	61.6	42.8	7
10	Chevalier	2	84	45	84	33	48	85	38	95	87	1.8	45.0	37.3	10
12	Black Hulless	6	83	58	78	31	58	80	29	60	Black	1.3	38.1	36.9	12
15	French Chevalier	2	83	47	82	31	49	80	36	80	85	1.7	53.3	43.3	15
21	Odessa	6	88	51	79	34	56	80	37	80	83	1.4	50.4	35.6	21
26	Manshury	6	83	46	79	39	48	80	42	90	84	1.5	56.6	39.7	26
27	Success	6	75	51	78	31	56	79	36	90	71	1.1	41.2	37.1	27
28	Bernards	6	83	47	80	36	48	80	42	85	84	1.6	53.3	38.4	28

the varieties. Five newer varieties secured previous to 1895 have been twice tested, and thirty-eight others received prior to 1896 were planted in 1896 in the Field Crop Garden and all that are promising will enter the field variety tests in 1897 or 1898. A few of our own crosses and numerous stocks improved by selection in our Field Crop Nursery will enter the variety tests within a few years.

CORN—VARIETY TESTS.

During the past several years 120 varieties of corn have been collected and placed under trial by the Minnesota Experiment Station. Many of these have been discarded after one or more trials. In Table XXXI sixteen of the best sorts

TABLE XXXII.—Corn. Varieties 16 Best out of 81 Kinds.

Univ. No.	Variety	Description.	Days Maturing. (Ave. of 2 yrs.)	Yield of Shelled Corn per acre. 1893.	1894.	1895.	1896.	Av. '93, '94-5-6.	Av. '94, '95, '96.	Average '95, '96.	Dry stover. Per acre, tons, 2 trials	Univ. No.
13	St. Paul	Y. D.	108	62	46.9	50.6	44.8	51	46	48	1.3	13
15	Calico	M. D.	114		57.4	62.5	51.0		57	57	1.7	15
18	Beaver's Long Seed	Y. D.	114		58.9	51.2	45.3		52	48	2.5	18
24	Cosgrove	Y. F.	112		56.3	59.4	66.3		61	63	2.4	24
26	Minnesota	Y. F.	108	44	45.2	53.2	60.2	51	54	57	1.6	26
30	New York	Y. F.	112	54	43.3	59.9	52.0	52	52	56	2.3	30
32	Squaw	M. F.	110	42	38.0	51.2	44.8	44	45	48	1.1	32
37	Cosgrove's	Sw't	108		38.4	42.5	52.0		44	47	2.2	37
47	Fuller's	M. F.	101			41.2	27.5			34	0.8	47
52	Pillsbury's	Y. F.	115			52.7	71.4			62	3.0	52
57	Dower's	Y. F.	112			49.7	52.0			51	1.5	57
65	Smut Nose	W. F.	112			60.4	66.3			63	2.3	65
66	Boss	W. D.	116			56.3	56.1			56	1.5	66
69	LaMont	Y. D.	111			67.4	48.4			58	1.7	69
72	Wilzbacher	Y. D.	109			60.2	54.0			57	1.2	72
74	White Cap	Y. D.	111			58.6	58.1			58	1.2	74

are grouped with a history of their yields. No. 13 has yielded well as compared with many discarded varieties and was the

first one chosen for dissemination. It is not only a good yielder but is early and a safe variety for farmers to plant in the southern one-third of the state. This variety has been sold to numerous farmers in the part of the state mentioned, and nearly all are very well pleased with it. In a few counties west and as far north as the Twin Cities it yielded heavily of fodder, and only moderately of ears, and was not quite early enough to mature on rich, heavy, cold lands. On warm soils, however, it has proven satisfactory as far north as St. Cloud. University No. 13 was the best yielder of the varieties first brought into our field trials of corn. During later years, however, we have secured other kinds which on further trial are proving even more promising for the southern one-third of the state. (See Nos. 15, 66, 69, 72 and 74 among the dent varieties in Table XXXII, and Nos. 24, 52 and 65 among flint varieties.) It is worthy of note that some of the flint varieties are our best yielding kinds. And the belief expressed in a former bulletin, that the flint varieties have become acclimated to a cold climate from having been longer grown at the north seems to be confirmed. Certainly for the middle and north thirds of Minnesota the flint varieties promise to be our best stocks from which to develop, by breeding, good varieties of corn adapted to the sections named. We are now making an earnest effort to secure the best varieties of corn for central and northern Minnesota, and we are anxious to secure stocks of seed of varieties which have been doing well in those parts of the state. We solicit correspondence with persons who have corn which is successfully grown in the northern half of the state and will gladly pay whatever is right for one-half bushel quantities of such varieties. Since frosts sometimes interfere with the ripening of even the earlier varieties we are testing kinds suited to growing for fodder in the northern part of the state. Some of the varieties, most promising for fodder, do not usually ripen their seeds as far north as it is desirable to use them, and the seed must be grown in the southern part of the state. Farmers or seedsmen growing good kinds of dent or flint corn in southern Minnesota, could develope a market for large quantities of seed for sowing for fodder in the northern coun-

ties of the state. There is at present nothing which has proven better for fodder in the central part of the state than the largest dent and flint kinds grown in southern Minnesota for large crops of grain, and probably the same varieties are best for fodder in the counties of the northern third of the state. Since considerable seed is planted per acre when sowing for fodder it is important that the supply of seed be comparatively cheap. The farmers of the north part of the state should have some easy means of securing seed of such early maturing kinds of corn as University No. 13 from sections where it is grown for the grain. And those who grow this and similar kinds of dent and also the flint corns could make money by saving seed of such varieties and selling it at enough above market prices of corn to give them a fair profit.

We shall begin to propagate for dissemination a few of the best yielding dent and flint varieties of corn mentioned in Table XXXII, and, while increasing the quantity of our stock of seed, selection will be carried on to increase the yields and the other good qualities of each of the best kinds. Thus we hope in a few years to have to disseminate still other varieties of corn which will add a little to the yields per acre of this important crop. That we have found varieties which give superior yields makes it desirable that we secure still other kinds which farmers may be growing and which may prove even better yielders than those we have already been able to secure.

Since it is expensive to continue growing so many, all the first eighty-one varieties given University numbers have been discarded except the sixteen above mentioned which have given the best yields. A few which were good yielders were discarded because we had not sufficient seed to continue growing them. The plan has been adopted of giving nothing field trials when we are unable to secure sufficient seed to plant the trial plots for a few years and have enough left to plant one or more acres from which to propagate the kind. In thus starting to grow a variety which gives especial promise of large yields we pursue the following general plan which has been previously noted in our bulletins:

One or more acres of land is well prepared by fertilizing, fall plowing and making a fine seed bed in the spring. The corn is planted in hills about four kernels to the hill. When several inches high all small and unpromising stalks are destroyed thus retaining only the stronger plants. Thorough cultivation is given. When the plants are tasseling the tassels, or male flowers, are destroyed on all plants not promising a good ear. These two selections insure that pollen from only the better stalks in the field will fertilize the flowers which produce the kernels on the ears to be chosen for seed. When the ears are ripe only the best ones are chosen. Thus we make both a selection of plants producing the pollen, or male parents, and a rigid selection of plants producing the ears chosen, or female parents. By selecting in this manner the yield can be increased, and the corn can be perfected in minor desirable points such as uniformity, form of ear, depth of kernel, position of ear on the stalk, leafiness of the fodder, etc.

CORN—METHODS OF PLANTING FOR FODDER.

In Table XXXIII are given the yields of corn planted in different ways to produce fodder. The table explains itself. The

TABLE XXXIII.—Corn. Methods of Planting for Fodder.

Plot.	Method of Planting.	Stage of growth when cut.	Date Cut.	Pounds of seed used per acre.	Yield Tons per Acre.		
					Field cured fodder.	Green fodder.	Dry matter in fodder.
1.	In furrows 4 in. deep and 30 in. apart, sown by hand, dragged level	No ears but getting dry at bottom of stalk.	Sept. 17th	150	6.8	15.5	2.2
2.	In furrows 4 in. deep and 44 in. apart, sown by hand, dragged level	"	"	96	7.7	23.6	3.0
3.	Sown with double drill, drills 7 in. apart, the double rows 37 in. apart, sown with Keystone drill	"	"	64	7.1	24.6	2.9
4.	In single rows 44 in. apart, kernels 2¼ in. apart in row	"	"	32	8.1	30.3	2.7
5.	In hills 22 in. by 44 in. apart, 4 kernels per hill	Cobs formed, kernels formed, just filling out.	"	16	6.6	12.5	2.5
6.	In hills 44 in. by 44 in. apart, 4 kernels per hill	"	"	8	4.0	20.2	2.0

variety used was University No. 13, a yellow dent variety found to do well in many sections of the state. The plots on which were planted 32 to 96 pounds of seed gave larger yields than those planted in hills or those planted in thick rows. Fields planted in this same manner, for feeding tests by the dairy division of the station, unfortunately, owing to unforeseen circumstances, could not be fed out to determine the milk and butter product per acre from corn planted in the several ways.

OATS, VARIETY TESTS.

In 1896 eighteen varieties of oats were tried in field variety tests at University Farm and at North East Farm. Table XXXIV gives the average yields of eighteen varieties chosen as the best of seventy-five kinds secured prior to 1894. The ten kinds of which the yields and numbers are given in full faced type are chosen as the best of the eighteen and will be retained for further trial while the remainder of the eighteen will be discarded from our field variety tests. The best of the ten will be increased in quantity to disseminate to the farmers of the different parts of the state. Thirty-nine other varieties were grown at University Farm for the first time in 1896. They with other newly secured kinds and numerous kinds originated by selection in our field crop nursery will be placed in the field variety tests and any proving better than those which have previously been selected as best will take their place for further test or dissemination. Two hundred and three varieties of oats altogether have been collected during the past several years. Many were discarded after testing in the field crop garden and only the best are tried in field plots. Of these some are discarded after a trial of one or a few years. Only the few best are retained for dissemination. Any new ones which prove better than the standards will be increased in quantity for dissemination and will be retained as standards with which to compare sorts which in the future may compete for selection as the best kinds and in their time be distributed. The points determined in testing the varieties of oats are yield of grain per acre, ability of the straw to stand erect on rich land, the

TABLE XXXIV.—Oats; Variety Test—18 Best Out of 75 Kinds.

University Number	VARIETY.	Panicle Opened or Closed.	Color—Brown, Yellow, Black, White.	Grade.	Weight per Bu., Av 1895 and 1896.	Days Maturing, Av '94, '95, '96.	1896. Per Cent Standing Up.	1896. Height in Inches.	1896. Yield Straw per Acre.	Yield of Grain, Bushels per Acre. 1894.	1895.	1896.	Average of Three Trials, University Farm.	University Number.
***4**	Early Swedish	C	W	88	33	92	75	44	1.5	44.0	63.3	34.4	47.2	4
***6**	Improved Ligowa	O	W	86	31	92	75	43	1.3	45.3	64.4	49.9	53.2	6
***8**	Archangel	O	W	84	39	86	75	38	1.4	46.8	63.7	48.9	53.1	8
19	White Wonder	O	W	88	35	83	15	37	1.4	63.1	44.5	32.2	46.6	19
***23**	Lincoln	O	W	84	30	92	95	41	1.4	48.4	59.8	48.4	52.2	23
***26**	Early Gothland	O	W	84	28	93	95	39	1.4	45.6	64.5	55.6	55.2	26
***29**	Archangel	O	W	85	39	89	75	42	1.7	51.9	82.2	49.5	61.2	29
***30**	Improved White Russian	O	W	87	30	85	10	42	1.7	58.7	69.5	36.7	55.0	30
***32**	White Wonder	O	W	87	33	94	80	42	1.5	53.7	82.2	50.0	62.0	32
33	White Russian	O	W	88	35	90	30	42	1.8	50.0	71.6	41.6	54.3	33
34	White Russian	O	W	85	31	93	70	43	1.4	46.6	73.0	53.1	57.6	34
***35**	White Russian	O	W	85	32	93	85	43	1.5	46.0	73.0	55.8	58.2	35
***36**	Giant Side	O	Y	82	34	100	100	43	1.3	30.1	68.4	37.4	45.3	36
38	Prize Cluster	O	W	85	33	93	75	40	1.4	40.0	54.8	47.5	47.4	38
***64**	Black Russian	O	B	78	31	93	75	42	1.4	44.3	79.0	46.6	56.6	64
65	Badger Queen	O	W	87	33	92	40	45	1.5	44.3	58.7	32.3	45.1	65
72	Japan	O	W	86	33	95	70	42	1.8	35.9	61.8	32.7	43.5	72
73	Horse Mane	C	W	80	33	94	70	47	1.6	.....	63.0	36.3	49.6	73

* The eleven best have their University numbers in full face type.

weight per bushel and the feeding quality of the grain. One sample of White Russian oats is now being increased in quantity for distribution. We hope to be able to have a quantity of seed to sell of a new kind each year hereafter. Fair prices for seed will be charged. We have none in sufficient quantity for distribution in 1897.

As will be seen by inspecting Table XXXIV, the oats called White Russian, are among the best yielders. They are plump, white oats with spreading panicles and strong stems. They have been grown by Mr. Adam Lindig and other neighbors around University Farm for a number of years. We have a good sample of this stock which we hope to disseminate within two or three years.

White Wonder, Univ. No. 32, Archangel, No. 29, White Russian No. 35, and Black Russian No. 64 gave the best four average yields.

Giant Side Oats, No. 36, is especially strong in standing erect as shown by its record both in 1895 and 1896. This oat may be of especial use on farms having lands either naturally very rich or kept rich by the use of large amounts of manure from live stock. It is, however, a very late oat and hardly adapted to the northernmost counties of the state. Improved White Russian oats, No. 30, did not yield so well as a number of other kinds but will be retained because this kind is one or two weeks earlier in ripening than most other kinds and may have an especial value in the north part of the state.

Giant Side oats may be of value in our work with breeding oats which will yield well on lands on which this crop is liable to lodge badly; and the Improved White Russian stock may be useful in originating new varieties early enough to escape the frosts in northern Minnesota.

WHEAT—VARIETY TESTS.

The Minnesota Experiment Station began in 1888 to collect varieties of spring wheat from the many parts of the world where spring wheats are grown. Notes on the variety tests have appeared in Minnesota Bulletins Nos. 15, 31, 40 and 46 and in North Dakota bulletins Nos. 10, 11 and 23. In 1896 only the eight best varieties were retained and

grown at University Farm. They were also planted at North-east and North-west Farms, but at the latter place the excessive rainfall destroyed the crop.

The variety tests mentioned with the more than 200 kinds from which the eight in Table XXXV have been selected as the best, were carried out in a practical way under ordinary field conditions.

University No. 13, Blount's Hybrid No. 15, is a beardless, white-chaffed spring wheat with berries of medium size, fairly plump in form and very light amber in color. Its chaff holds the berry more closely than does the chaff of red fife. Its grade, as passed upon by those accustomed to Minnesota standards, has ranged during the six yields from No. 3 northern to No. 1 hard. We have not had its flour making quality determined. It has yielded quite as well as our best varieties of red fife and seems quite worthy of further trial. This wheat was originated by crossing by Prof. Blount, formerly of Colorado Agricultural College.

University No. 19, White Russian, as grown in our trial plots, is also a beardless, white-chaffed variety. It grows large in stem with large spikes and its berries are rather larger than those of Red Fife and their color is good. Its chaff holds to the berry and protects it as does red fife. It is a somewhat softer wheat than red fife and during the several years has graded one to three grades below that of that standard wheat grown beside it. And while it has yielded slightly more bushels per acre it cannot at present be considered better.

University No. 51, Haynes Blue Stem, was secured from Mr. L. H. Haynes of Fargo, N. D. It is the result of much patient selection from the ordinary blue stem so commonly grown through the Northwest. It is a tall, heavy plant with heads of medium length; beardless, and its white chaff is covered with thick hairs; hence the name Velvet Chaff is sometimes applied to it. During five trials it twice graded lower than red fife grown beside it and once, higher. All blue stem wheat has a fault in that the chaff does not hold tightly to the berry as in case of red fife. This results in loss in the quality of the wheat. Exposure of the bran of the berry causes it to be more brittle and harder to be success-

TABLE XXXV.—Wheat. Eight best of 200 Collected Varieties.

Univ. No.	VARIETY.	Height 1896.	% Lodged 1896.	Length of Head.	Bearded or Smooth.	Color of Chaff.	Chaff Velveted or Smooth.	Chaff Holds.	Days Maturing 1896.	Weight per Bushel in 1896.	1892. Yield. Fargo.	1892. Grade.	1893. Yield. Fargo.	1893. Grade.	1894. Yield Coteau.	1894. Grade.	1895. Yield Coteau.	1895. Grade.	1895. Yield University Farm.	1895. Grade.	Yield N. D. Ex. Sta., 1896.	Yield Univ. Farm. 1896.	Grade 1896.	Average of Seven Yields.	Univ. No.
13	Blounts Hybrid No. 15.	48	15	3.2	S	W	S	MtoG	101	57	17.3	3 N	12.8	1 N	23.8	1 N	23.5	1 H	29.0	1 N	17.0	21.2	2 N	20.7	13
19	White Russian........................	50	20	3.8	S	W	S	Good	100	55	17.7	2 N	11.9	1 N	23.0	1 N	21.5	3 N	33.2	3 N	19.7	24.8	2 N	21.7	19
51	Haynes Blue Stem..................	50	5	3.2	S	Brown & White	V	Med	101	57	16.6	1 H	14.6	1 N	20.6	3 N	24.7	1 H	21.6	1 N	23.4	24.6	2 N	20.9	51
66	Powers Fife..........................	47	15	2.6	S	W	S	MtoG	101	56	21.3	1 N	15.1	1 H	19.8	1 H	22.8	1 H	26.3	1 N	22.5	21.4	2 N	21.3	66
72	Rio Grande......	48	15	3.6	B	W	S	Good	100	57	22.6	2 N	11.2	1 N	21.0	1 N	20.7	2 N	29.3	1 H	18.0	20.2	3 N	20.4	72
105	Glyndon 711..........................	46	30	3.0	S	W	S	MtoG	101	56	23.3	2 N	10.0	1 N	21.4	1 N	22.8	1 H	31.8	1 H	18.2	21.4	2 N	21.3	102
116	Glyndon 753..........................	49	35	2.8	S	W	S	Med	101	56	14.7	2 N	14.3	1 N	19.3	1 N	20.6	1 N	31.5	1 N	17.0	21.0	2 N	19.8	116
146	Bolton's Blue Stem................	50	15	2.7	S	W	V	Good	101	56	......	......	17.8	1 N	21.4	......	20.0	1 H	35.3	1 H	23.2	25.1	2 N	23 7	146

fully ground by the roller process. The effect of the weathering on the berry is shown by bleaching, and as the miller can detect this fault the wheat does not, as a rule, grade quite so high as fife grown, harvested, shocked and threshed under the same conditions. During recent years Mr. Haynes has been hand selecting his wheat to correct this fault common to all blue stem. Tests made by this station and by millers place blue stem as the equal of fife if the blue stem has been well cared for. It would seem that if blue stem has been so harvested, shocked and stacked that the berries are not exposed to the weather it is quite as good as fife wheat. But, as a rule, both kinds are subjected to more or less unfavorable conditions of weather and the fife having close holding chaff, receives less injury to its berry. This sample of blue stem is one of our best wheats and has yielded about the same as Power's Fife, which is a superior stock of red fife wheat. We have one other stock of blue stem wheat which has proven even a better yielder that that received from Mr. Haynes, viz., Bolton's Blue Stem (See University No. 146, Table XXXV and below). The plants of blue stem are larger and leafier than those of fife; the berries are larger, more slender, and when not injured by the weather they have the appearance of being nearly as "hard." The common belief seems well founded that blue stem wheat as ordinarily grown throughout the Northwest averages a few bushels per acre more than the fife commonly grown, and in spite of not grading quite as high in the markets it seems to be the more profitable in most sections. Owing to the plant being larger and stronger than fife, blue stem combats the weeds more successfully where the lands are worn or full of foul seeds. Owing to its habit of opening its chaff away from the berry as soon as ripe and letting the grain shatter out of the standing crop, this variety of wheat is at a disadvantage on large farms where the wheat cannot be harvested as soon as ready. Under such conditions its yield is often cut down below the yield of fife.

University No. 66, Power's Fife, is a stock of red fife wheat reputed to have been originated by Mr. James Holes of Fargo, N. D., from a single plant of wheat growing in the

edge of an oat field. This wheat was chosen in the early history of our trials as a standard with which to compare all other kinds. In our variety tests it seems to have averaged as well or better than several other stocks of fife wheats we have tried. Mr. Holes, Hon. J. B. Power, of Power, N. D., and others have distributed large quantities of this stock of fife wheat, in some cases car load lots having been sold for seed. Like all red fife wheat Powers' Fife has medium or small sized berries, reddish in color, of medium form, hard and flinty in appearance and without a peer in the Northwest in gaining high "grades" in the hands of the grain inspectors. This is the class of wheat which has formed the basis of the "No. 1 hard" grade in Minnesota and surrounding states. This wheat is of especial value for mixing with softer wheats, making it possible to make a large percentage of standard patent flour out of the mixture. The plant of red fife wheat is rather small though the straw is stiff, the glumes are beardless, and the chaff is white and not hairy. We are surprised that we have found with all our experimenting that there seems to be no variety of wheat much better for the Northwest than fife. We had expected to find at least some wheats, possibly of poor quality, which were better yielders.

The wisdom of the course outlined some years ago in our breeding experiments, in that we would expend our energies in bettering our plain practical wheats, rather than in trying to breed something wonderful by trying to cross many new kinds seems to have been proven. We have in fife, and in a lesser degree in a few other kinds of wheat, varieties which have become acclimated and have stood the test of wide experience. And, while we shall try to secure from outside sources new, promising wheats, wisdom seems to direct us to improve these practical varieties by breeding, thus increasing the yields of these wheats, the milling qualities of which are so excellent.

University No. 72, Rio Grande, has been grown by the experiment station for a number of years. It is a medium sized plant, bearded, chaff is smooth, white and holds tightly

to the berry. The berry has much the same appearance as the red fife, but has usually graded one grade below fife grown beside it. As it is bearded, hardly as good a yielder as fife and blue stem, and not able to secure as good grades, this variety will hardly compete with the standard sorts. This wheat at times has seemed especially susceptible to the effects of rust.

University No. 105, Glyndon 711, though it came to us under another name, has the appearance of ordinary fife wheat. This wheat was secured by Mr. D. N. Harper in 1889 from Mr. Thos. E. Heenan, U. S. Consul at Odessa, Russia, under the name of Polish Winter. It is a very good sample and we planted last year at Northwest farm a field of 25 acres that we might have a few to several hundred bushels to disseminate throughout the state. The excessively wet season destroyed the crop and as we had planted most of our stock it really delayed its dissemination two years.

University No. 116, Glyndon 753, is a beardless wheat with white, hairless chaff. Its color and appearance of hardness have not warranted its receiving so high a grade as fife wheat. Its average of seven yields is below that of fife and blue stem.

University No. 146, Bolton's Blue Stem, is a stock of blue stem wheat received through North Dakota Agricultural Experiment Station from Mr. Thos. Bolton of Park Rapids, N. D. This variety, so far as known, has not been especially selected out from the common stock of blue stem wheat. But it has given a yield even above the excellent sample of Haynes' blue stem and has outyielded Powers' fife by over two bushels per acre. Bolton's blue stem was in one less of the annual tests than was Powers' fife, but when the average is made for only six trials in both cases the comparative yields remain the same. This seems to be such an excellent stock of blue stem wheat that we shall try to disseminate it at an early date.

WHEAT—SMALLEST VS. LARGEST VS. HARDEST KERNELS FOR SEED.

In 1892 W. M. Hays, who was then at North Dakota Ex-

periment Station grew in the Field Crop Nursery several hundred plants of wheat, by planting single grains in the hills twelve by twelve inches apart. The plants producing most heavily of grain were separately harvested and weighed, the weight being recorded in grams. The plants mentioned in this experiment ranged in yield from 9 to 19.3 grams per plant.

In 1893 eight plants were chosen and from the seed of each of these plants kernels of each of two or three classes were carefully selected out. One hundred of the largest, one hundred of the hardest, and (in a few cases) one hundred of the smallest kernels were selected and planted in the 1893 field crop nursery at Fargo. One seed was sown in the hills 12 by 18 inches apart. When these plants were ripe the best plants (about three-fourths of all) were harvested, the seeds being all thrown together in bulk. The grain from the smaller, weaker one-fourth of the plants was discarded.

In 1894 these samples of wheat, eighteen in number, were sown in small plots with an ordinary grain drill. The plots of wheat were harvested, threshed and the yields per acre were calculated. The plots were small, however, and the 1894 yields are not used in Table XXXVI.

Enough wheat was produced so that in 1895 twentieth acre plots were grown under ordinary field conditions and the yields were carefully taken. In 1896 similar plots were grown of all varieties both at University Farm and by Prof. Shepperd at North Dakota Experiment Station.

In Table XXXVI are given, in columns 12, 13 and 14, the three yields from the trials above mentioned, and in column 16 are the averages of the three yields.

In only two cases have we the yields from grain produced by the smallest as well as by the largest and hardest kernels. Here the average yields compare as follows:

The six yields of Univ. Nos. 147 and 170 from smallest seeds averaged 28.5 bushels per acre.

The six yields of Univ. Nos. 148 and 175 from largest seeds averaged 26.8 bushels per acre.

The six yields of Univ. Nos. 149 and 169 from hardest seeds averaged 28.2 bushels per acre.

TABLE XXXVI.—Wheats.—Selection of Smallest, Largest and Hardest Kernels for Seed.

University No.	VARIETY USED.	1892. Plant No.	Numb. of Kernels in 1 Gram.	Wt. of 100 Kernels in Grams.	Yield of Mother Plant, Grams.	Century, 1893.	Grade. 1894.	1895.	1896.	Av. Wt. per bu. 1895-96.	Yield. 1895.	1896.	'96, Fargo	Selected for	Average three yields.	University No.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
147	Powers Fife	108	39	2.1	9.0	401- 500	2N	1H	2N	59.5	35.7	23.4	23.2	Smallest	27.4	147
148	" "	108	39	3.1	9.0	501- 600	2N	1H	1N	60.0	35.	22.7	21.7	Largest	26.5	148
149	" "	108	39	2.6	9.0	601- 700	2N	1H	2N	60.0	36.2	23.3	22.7	Hardest	27.4	149
170	Haynes Blue Stem	476	36	2.0	19.1	6701-6800	3N	1N	2N	58.0	37.9	27.	24.3	Smallest	29.7	170
175	" " "	476	36	3.0	19 1	6801-6900	3N	1N	2N	57.0	32.5	25.2	23.5	Largest	27.1	175
169	" " "	476	36	2.5	19.1	6901-7000	3N	1H	2N	57.0	37.8	25.	24.3	Hardest	29.0	169
180	" " "	551	40	2.0	19.3	7801-7900	3N	1N	2N	56.5	28.8	25.4	24.5	Smallest	26.2	180
161	" " "	551	40	3.3	19.3	7901-8000	Rej.	1H	2N	57.0	27.2	25.	Lost	Largest	.....	161
173	" " "	551	40	2.9	19.3	8001-8100	3N	1N	2N	57.0	34.7	25.8	24.5	Hardest	28.3	173
154	G. 818	2540	46	2.5	15.5	3401-3500	2N	1H	2N	57.0	30.3	17.7	21.3	Largest	23.1	154
155	"	2540	46	2.4	15.5	3501-3600	2N	1H	2N	59.0	32.3	23.3	23.3	Hardest	26.3	155
151	Powers Fife	76	54	2.6	11.8	1201-1300	2N	1H	.....	59.0	32.6	20.6	18.5	Largest	23.9	151
152	" "	76	54	2.2	11.8	1301-1400	2N	1H	2N	59.0	34.3	20.8	22.2	Hardest	25.8	152
157	G. 753	1277	40	2.9	11.0	4401-4500	2N	3N	2N	58.5	30.9	22.	27.5	Largest	26.8	157
158	"	1277	40	2.3	11.0	4501-4600	2N	3N	Rej.	58.5	31.9	24.7	26.7	Hardest	27.8	158
182	"	1326	42	2.9	13.8	5401-5500	3N	1H	2N	56.5	27.2	23.	25.2	Largest	25.1	182
162	"	1326	42	2.4	13.8	5501-5600	2N	3N	Rej.	58.5	33.8	24.1	22.3	Hardest	26.7	162
178	G. 761	1695	44	2.8	14.7	12201-12301	3N	1H	Lost	57.5	30.	Lost	27.5	Largest	.....	178
176	"	1695	44	2.2	14.7	12301-12400	2N	3N	Lost	58.0	29.2	Lost	21.7	Hardest	.....	176

In case of the progeny of seven of the original plants we have the yields of grain produced by the largest and the hardest kernels. The averages of twenty-one yields of the seven "largest" and a similar number of the twenty-one "hardest" are as follows:

Twenty-one yields of grain from largest selected kernels, 25.4 bushels per acre.

Twenty-one yields of grain from hardest selected kernels, 27.1 bushels per acre.

Strange as it may seem the largest kernels have given poorer yielding varieties than the smallest kernels, as well as poorer than the hardest kernels, and the smallest kernels in the fewer trials gave a heavier yield than the kernels of medium and larger size selected for their apparent hardness. In selecting this last named class grains were chosen of that "hardness" which millers and inspectors class as No. 1 hard, flinty and almost transparent, the bran well filled, highly colored and apparently smooth and tough.

The experiment shows that the heavy, hard kernels produced varieties yielding nearly two bushels per acre more than the largest kernels, and certainly emphasizes the importance of selecting seed wheat of high quality and heavy weight.

WHEATS—SAUNDER'S CROSS-BRED VARIETIES COLLECTED IN 1895.

In 1895 the Station received from Prof. Wm. Saunders, director of the Dominion Experimental Farms, Ottawa, Canada, five varieties of wheat which he had originated by crossing. In Table XXXVII are given the yields of these varieties at University Farm in 1895 and 1896 and Prof. J. H. Shepperd has kindly sent yields at North Dakota Experiment Station, Fargo, in 1896. University No. 188, "Preston," and University No. 185, "Advance," gave the largest average yields for the three trials, 30.4 bushels and 27 bushels per acre respectively. It is worthy of note that the cross-bred variety which Prof. Saunders has named Preston, averaged higher than any of our varieties originated by selection. The three trials of all these kinds were made side by side at University Farm and at Fargo. Our University Nos. 164, 163, 170,

TABLE XXXVII.—Wheats, Saunders' Cross-Bred Varieties Collected in 1895.

University No	Variety.	Cross Between	Bearded or Smooth.	Color of Chaff.	University Farm 1896.				Yield Grain per Acre.			Averages 1895-1896 University Farm.		Grain per Acre, Average Three Trials.	University No.
					Grade.	Days Maturing.	Height in Inches.	Per Cent Lodged.	University Farm 1895.	University Farm 1896.	N. D. Exp. Station 1896.	Weight per Bushel.	Straw per Acre.		
185	Advance....	White Fife and Ladoga	B	Brown	1 N	94	44	10	45.4	18.7	17.0	56.0	2.1	27.0	185
186	Crown.....	" " " "	B	"	2 N	94	45	10	36.2	18.7	18.2	54.5	1.7	24.3	186
187	Stanley	Red " " "	S	Brown / White	2 N	94	45	5	37.5	18.0	15.2	56.0	2.3	23.5	187
188	Preston.....	" " " "	B	Brown	1 H	94	46	4	44.0	27.0	20.2	56.5	2.3	30.4	188
189	Percy.....	White " " "	S	Brown	1 N	94	43	7	29.7	19.7	17.2	55.5	1.8	22.2	189

NOTE.—The yields and averages are comparable with the yields and averages of our standard and new wheats in Tables XXXV and XXXVI.

averaging 30.3, 29.7 and 29.7 respectively come near to this best yielding kind from Prof. Saunders. Prof. Saunder's "Advance" which has our University No. 185 has also proved a good yielder. In disseminating our varieties originated simply by selection from our standard hard wheats we shall feel a great deal of assurance regarding their quality. In case of these Saunder's cross-bred varieties and our own cross-bred wheat, which we are now testing as to yield, we may find it necessary to carry out milling and baking tests before sending them out from the Station. A study of the new kinds in the laboratory seems desirable also. The crosses made in producing these wheats are shown in Table XXXVII.

PEAS, FIELD VARIETY TESTS.

In bulletins No. 40 and No. 46 are reports of yields of numerous varieties of field peas. In 1896 nineteen of the better yielding varieties were again grown and in Table XXXVIII are given the yields for 1894, 1895 and 1896, with averages for the three years. These yields have been obtained by ordinary, practical field treatment on soil of medium character as to its fertility and water holding powers. The peas were planted two and one-half to three bushels per acre—less seed per acre being planted of varieties with smaller berries and more of varieties with larger berries. The peas were sown with Dowagiac drill with pea attachment about four inches deep in plots about one rod wide by eight rods long. The yields in 1894 were very light owing to the unprecedented drouth of that season. Since the comparison of the yields for the two favorable years gives more nearly ordinary yields and makes the comparisons more equitable the averages for 1895 and 1896 are given separately in column 11 of Table XXXVIII while the averages for the three years are given in column 10. University Nos. 9 and 24 are commonly known as White Canada, which variety stands at the head as a good yielding kind. The seeds of this variety are small, smooth and round. The vines are rather large and slender. University No. 15, Alpha, stands third in its ability

to yield large crops under the conditions of these trials. University No. 21, Crown, stands fourth and University No. 25, Prince of Wales, stands fifth. University No. 14, Black Eyed Marrowfat, stands sixth. Some of these stocks are being improved by selection and crossing and the best will in time be grown in quantity for distribution.

TABLE XXXVIII.—Peas—Variety Tests.

University No.	VARIETIES.	Days Maturing	Evenness of Ripening.	Per Cent Standing Up.	Tons Straw 1896.	Yield Grain, Bu. 1896.	1894.	1895.	Average of Three Trials, Univ. Farm.	Average of 1895 and 1896 Trials.	University No.
1	Mummy	86	85	55	.....	19.0	2.7	16.8	12.8	17.9	1
3	Crown	86	75	50	.....	20.2	.....	18.2	.....	19.2	3
4	Prussian Blue	93	60	10	1.5	19.2	4.5	20.8	14.8	20.0	4
5	Centennial	92	85	45	1.4	21.4	4.2	18.6	14.7	20.0	5
7	White Canada Field	92	50	5	1.7	19.0	2.7	16.4	12.7	17.7	7
9	" " "	84	80	50	.....	26.0	6.5	29.7	17.9	23 4	9
14	Black Eyed Marrowfat	86	85	50'	.....	19.7	5.2	21.2	15.3	20.5	14
15	Alpha	79	90	50	.....	18.7	8.6	25.9	17.7	22.3	15
19	Blue Prussian	91	80	90	2.0	17.9	4.3	21 9	14.7	19.9	19
21	Crown	84	55	80	.....	21.7	7.2	21.7	16.8	21.7	21
22	Golden Vine	91	40	70	1.8	19.2	5.7	15.5	13.4	17.4	22
24	White Canada Field	80	80	50	.....	22.3	9.2	23.0	18.1	22.7	24
25	Prince of Wales	84	80	50	.....	21.0	9.2	21.7	17.3	21.4	25
26	Pride of the Market	84	75	60	.....	15.0	8.2	15.3	12.8	15.2	26
27	Green Canada Field	92	85	80	1.3	19.2	7.8	18.6	15.2	18.9	27
29	Audobon	91	75	50	1.7	22.2	7.0	16.1	15.1	19.2	29
30	Black Eyed Marrowfat	91	70	15	1.1	14.2	.....	17.3	.....	15.8	30
31	Potter	91	75	20	1.8	22.2	6.7	15.4	14.7	18.8	31
33	Prince Albert	91	35	40	1.5	19.6	6.6	15.7	13.9	17.6	33

ROOT CROPS.—VARIETY TESTS.

During the past several years this Experiment Station has tested varieties of root crops with a view to finding what are the best kinds to grow in Minnesota for feeding to stock. In table XXXIX are given the results of trials in 1896.

TABLE XXXIX. - Root Crops, Variety Tests.

MANGELS.

University No.	VARIETY.	Color.	Average Size. Inches.	Length, Inches.	Yield per Acre. Tons.	Days Maturing 1895.	Days Maturing 1896.	SOURCE OF SEED.	University No.
18	Mammoth Long Red	Red	3.4	15	29.2	.....	141	John King, Coggshall, England.	18
11	" " "	Red	3.4	14	21.6	.....	141	Dippe Bros., Quedlenberg, France	11
10	Eckendorf Yellow	Yellow	4.0	11	21.3	.....	141	Dippe Bros., Quidlenberg, France	10
25	Biffel Tower	Red	3.2	15	21.3	.....	144	John A. Salzer Seed Co., La Crosse, Wis	25
9	Eckendorf Red	Red	3.8	10	20.4	.....	141	Dippe Bros., Quedlinberg, France	9
8	Mammoth Long Red.	Red	3.8	15	19.9	.....	140	Henry de Vilmorin, Paris, France	8
2	Yellow Smooth Erfurt	Orange	3.4	11	18.5	.....	139	Ernest Benary, Erfurt, Germany	2
1	Mammoth Long Red	Red	3.6	15	18.2	.....	139	" " " "	1
5	Olive Shaped Yellow	Yellow	3.8	12	16.2	.....	139	" " " "	5
26	Giant Holstein	Red and White	3.2	12	16.0	.....	144	J. A. Salzer Seed Co., LaCrosse, Wis	26
3	Red Smooth Erfurt	Red	3.4	14	15.6	.....	139	Ernest Benary, Erfurt, Germany	3
4	Golden Tankard	Deep Orange	4.2	12	15.2	.....	139	" " " "	4
7	Giant Yellow Intermediate	Deep Orange	3.6	13	15.2	.....	140	Henry de Vilmorin, Paris, France	7
20	Golden Tankard	Very Deep Orange	3.4	9	14.8	.....	141	John K. King, Coggshall, England	20
6	Olive Shaped Red	Red	3.6	12	14.6	.....	140	Ernest Benary, Erfurt, Germany	6
19	Prize Yellow Globe	Yellow.	5.4	7	14.4	.....	144	John K. King, Coggshall, England	19
16	Golden Tankard	Deep Orange.	4.2	10	9.5	.....	139	J. D. Fredrickson, Little Falls, N. Y.	16

SUGAR BEETS. (*Table XXXIX continued*).

University No.	VARIETY.	Color.	Average Size.	Length.	Yield per Acre. Tons.	Days Maturing 1895.	Days Maturing 1896.	SOURCE OF SEED.	University No.
13	203f	Red	3.6	13	21.5	.....	143	Haagre Schmidt, Erfurt, Germany	13
15	2025	Red	3.6	13	17.3	.....	143	" " " "	15
28	Ertragreicher	White	3.2	9	15.5	.....	143	C. H. Deitz, New York, N. Y	28
17	Queen of Denmark	Pink	3.8	11	15.0	.....	143	J. D. Fredrickson, Little Falls, N Y	17
42	Imperial	White	3.4	12	14.6	.....	143	Franz G. Zimmel, New York, N. Y	42
12	2022	Red	4.0	12	13.6	.....	143	Haage & Schmidt, Erfurt, Germany	12
27	Zuckerreicher	White	3.4	10	13.3	.....	143	C. H. Dietz, New York, N. Y	27
43	Improved Klein Wanzliebener	White	4.0	11	12.8	.....	143	Franz G. Zimmel, New York, N. Y	43
41	Lion	White	3.8	12	11.4	.....	143	" " " " "	41
22	Egyptian Turnip Rooted	Red	3.6	5	10.8	.....	143	John K. King, Coggshall, England	22
14	2024	White	5.0	11	9.8	.....	143	Haage & Schmidt, Erfurt, Germany	14
21	Long Dark Blood Red	Red	2.4	10	8.4	.....	143	John K. King, Coggshall, England	21

RUTABAGAS.

31	American Purple Top	Purple Top, White Bottom	4.4	7	11.2	143	Northrup, Braslin & Goodwin Co., Mpls., Minn.		31
29	Prize Winner	" "	4.2	7	10.8	143	N. B. & G. Co., Minneapolis, Minn.		29
24	Swedish American Purple Top	" "	4.6	6	9.2	143	John K. King, Coggshall, England		24
30	Sweet German	White	4.2	6	9.2	143	Northrup, Braslin & Goodwin Co., Mpls., Minn.		30
32	White Russian	White	4.4		9.2	143	" " " " " " "		32
23	Swede Monarch	Purple Top, White Bottom	4.4	6	5.9	143	John K. King, Coggshall, England		23

TURNIPS.

33	Purple Top White Globe		7.0		11.2	126	Northrup, Braslin & Goodwin Co., Mpls., Minn.		33
34	White Egg		5.0		10.4	126	" " " " " " "		34
36	Purple Top Strap Leaf		5.5		10.4	126	" " " " " " "		36
35	White Strap Leaf		5.0		4.6	126	" " " " " " "		35

CARROTS.

38	White Belgian	White	3.2	12	12.0	144	Northrup, Braslin & Goodwin Co., Mpls., Minn.		38
40	Victoria	Yellow	2.6	14	9.8	144	" " " " " " "		40
37	Yellow Belgian	Yellow	2.8	14	5.2	144	" " " " " " "		37
39	Mastodon	White	4.2	12	4.5	144	" " " " " " "		39

SUGAR BEETS.—COST OF PRODUCTION PER ACRE AND PER TON.

In bulletin No. 21 of this station the cost per ton of raising sugar beets was shown to be $3.25 per ton on weedy land and $2.09 on land quite free of weeds. In that calculation the rental of the land was reckoned at $3.00 per acre and the beet seed was valued at 20 cents per pound.

In 1896 a trial was made again with the result shown in Table XL. The labor is reckoned at $31 per month, the laborer boarding himself. Two horses with implements are counted equal to a man. Two and one-half dollars per acre are allowed for the rental of the land. Seven pounds of seed per acre costing 20 cents per pound were used. The cost per acre is $32.17 and with fifteen tons of beets per acre the cost is only $2.24 per ton. The cost of the beets at the factory including the hauling would be greater in proportion to the distance hauled. And if the beets must be stored to prevent freezing before the factory can make use of them cost for storage, of pits, buildings or cellars, also the cost of an additional handling must be added. The beets were produced under conditions only slightly more favorable than ordinary. While the land is in good condition the labor is unusually high priced. The conditions are no more favorable than most farmers could have on the best parts of their farms if they were accustomed to raising sugar beets. And while the yield is somewhat better than the farmers would, on the average, obtain the cost is also greater for labor.

The Minnesota Experiment Station has proven that beets of good quality can be cheaply raised in this state, particularly in the southern half.

TABLE XL.—Sugar Beets Cost of Production per Acre and per Ton.

Time in Hours Required to				Cost at $31 for 260 Hours.										
Plant.	Weed and Hoe.	Horse Cultivate.	Harvest.	Plow.	Harrow and Pulverize.	Plant.	Hoe and Weed.	Horse Cultivate.	Harvest.	Rent of Land per Acre.	7lbs Seed at 20c.	Total Cost per Acre.	Yield Tons.	Cost per Ton.
4	124	11	80	1.25	1.00	.44	14.75	1.31	9.52	2.50	1.40	32.17	15	2.18

ROTATION OF CROPS—CROSS ROTATION EXPERIMENTS.

The cross rotation experiment mentioned on pages 288 both of bulletin No. 40 and of the annual report for 1894, and on pages 369 to 373 of bulletin No. 46 and annual report for 1895, has been completed so far as its continuance on Field E is at present concerned.

The purpose of this experiment is to show the effect each crop has on the yields of the crops which follow it in the rotation and to determine the order in which the crops in the rotation should follow each other.

In 1894 Field E was divided into six equal strips, which we call series, each eight rods wide and about thirty-six rods long. It was designed that this land should be planted to six kinds of crops, viz: field peas, mangels, potatoes, flax, wheat and corn, for three years. The strips or series lie north and south and the crops were planted one on each series in 1894. There being rod-wide alleys between the series it was practicable to divide each series into twelve plots, each three rods by eight rods and the yield of the crop produced on each separate plot was thus determined. The second year of the experiment (1895) the same six crops were grown in strips, but this time crosswise or at right angles with the strips of 1894. As the plot lines were kept in the same places as during the first year we were thus able to grow each of the six crops on land which had grown each crop the previous year and to observe the comparative yields. The third year of the experiment the several crops were again planted in the series running north and south and again divided up into plots as in the two previous years, thus again growing each crop after each other crop. Thus for a second time we were able to compare the yields of each crop after each other crop.

In Table XLI if we let the vertical double lines represent the rod-wide alleys between the series and the horizontal lines of figures represent the plots, we have approximately the form of that part of Field E used in the experiment.

The Roman numerals at the top, II to VII, designate the series and the Arabic numerals 1 to 12 both on the right and

TABLE XLI.—Rotation Experiment—Cross Rotation Showing Actual Yields of All Plots in 1894, 1895 and 1896.

Plot.	Crop.	VII.			VI.			V.			IV.			III.			II.			Plot.
		Corn '94.		Corn '96.	Wheat '94.		Wheat '96.	Flax '94.		Flax '96.	Potatoes '94.		Potatoes '96.	Mangels '94.		Mangels '96.	Peas '94.		Peas '96.	
12	Corn, '95	9.2	36.7	45 8	18.0	27.5	11.1	8.3	25.2	8.4	6.2	38.9	61.6	6.8	43.3	11.7	11.8	58.4	25.3	12
11	Wheat, '95	9.9	29.5	63.0	11.9	20.6	12.4	8.6	21.3	9.2	20.5	34.0	61.2	6.0	35.7	12.1	12.1	34.0	30.6	11
10	Flax, '95	9.8	11.9	61.1	11.7	8.9	13.0	7.5	7.3	9.6	23.9	18.4	56.0	6.6	13.8	12.0	10.5	16.4	30.4	10
9	Potatoes, '95	10.5	158.9	62 5	12.9	115.5	17.0	8.7	122.2	8.1	14.3	103.3	92.8	7.0	220.5	13.3	10.0	194.2	31.7	9
8	Mangels, '95	9.9	9.6	60.2	15.6	7.6	13.0	8.2	7.7	10.4	16.4	12 2	77.2	6.7	11.2	9.1	7.7	12.0	29.8	8
7	Peas, '95	10.5	19.9	65.7	18.4	16.7	16.3	7.8	12 1	10.8	10.3	18.6	64.4	7.5	11.8	9.9	9.3	13.4	25.1	7
6	Corn, '95	9.9	69.9	71.3	19.5	57.3	15.5	8.3	47.0	7.7	10.2	58.4	66.6	5.5	56.1	12.3	9.2	43.5	30.0	6
5	Wheat, '95	10.7	33.6	63.0	19.9	30.2	18.5	9.3	25.9	10.2	17.1	32.8	55.5	7.1	28.5	10.5	8.4	22.1	26.1	5
4	Flax, '95	11.1	14.3	70.3	16.6	14.2	16.9	8.1	8 4	4.1	27.3	13.5	48.0	5.4	9.9	9.7	9.5	11.3	26.4	4
3	Potatoes, '95	11.3	204.4	69.4	22.3	187.8	20.9	8.3	133.3	6.8	17.0	183.3	74.0	5.1	88.8	11.3	10.0	73.3	31.0	3
2	Mangels, '95	7.4	10.5	56.5	22.9	11.5	17.7	8.8	10.1	8.6	13.3	14.0	65.0	4.5	9.4	8.8	8.8	8.6	25.7	2
1	Peas, 95	3.3	32.0	51.8	25.1	23.0	19.1	8.5	26.9	11.5	17.5	28.4	52.9	5.6	16.5	8.7	6.7	17.3	27.5	1

NOTE.—In 1894 the corn was harvested for silage and the yield is given in tons. In 1895 and 1896 the yield is given in bushels of shelled corn.

the left are in line with and designate the plots in each of the series.

For example, in 1894 and again in 1896 Series II was planted to field peas, and when ripe the series was divided up into twelve plots and the crop harvested. The yields of grain in 1894 on the several plots are shown by the left hand column of figures in the series and the yields in 1896 by the figures in the right hand column. In like manner Series III bore a crop of mangels which were similarly harvested in plots. Series IV bore potatoes. Series V bore flax, series VI wheat and series VII corn.

In 1895 the crops were planted across the field in twelve narrow belts, running east and west at right angles to the several series. Thus the peas were in the plots numbered 1 throughout all series, and since there were twelve plots in each series and only six kinds of crops the seventh plot of each series was also planted to peas. Thus duplicate yields of the peas were obtained. Mangels were planted on plots 2 and 8, potatoes on plots 3 and 9, flax on plots 4 and 10, wheat on plots 5 and 11 and corn on plots 6 and 12 of each series. In Table XLI the yields of all these crops grown in 1895 are shown in the middle vertical column. To better display these 1895 yields the names of the crops and the figures showing the yields are printed in full faced type.

To illustrate Table XLI take, for instance, plot 12 of Series III: In 1894 mangels were grown on this plot (as on the whole series) and yielded 6.8 tons; in 1895 corn was grown on this plot and yielded 43.3 bushels and in 1896 mangels were again grown on this same plot and yielded 11.7 tons. Further we see that in 1895 corn yielded on Series VII, plot 12 (after corn) 36.7 bushels, on Series VI plot 12 (after wheat) 27.5 bushels, on Series V plot 12 (after flax) 25.2 bushels, etc. And in 1896 corn yielded on Series VII plot 12 (after corn) 45.8 bushels, on Series VI plot 11 (after wheat) 63 bushels, on Series VII plot 10 (after flax) 61.1 bushels, etc.

In Table XLII yields of the duplicate plots are averaged, thus giving the figures at once more compactly and with whatever of correction comes from averaging results. This table will be read in the same manner as Table XLI. In addition to

averaging the yields of the duplicate crops the yields for 1895 and 1896 are further corrected on the basis of the yields of 1894 on the same plots. Thus if the yields in 1894 showed that in some plots the land was naturally richer than others the yields on these plots in 1895 and 1896 were corrected on the basis of the differences shown in 1894.

In Table XLIII the comparison of yields of the different plots is shown when reckoned in percentages instead of in the actual yields, and these percentages are used in Tables XLIII, XLIII and XLV exactly as the actual yields. To obtain these figures the average yields of the several plots of each crop each year is taken as 100 and the yields for that year reduced to the form of percentages, thus comparing all yields on the basis of 100 taken as the average of each crop for each year.

The percentages of the crops in 1896 are based on the six yields printed in common type in the vertical columns while the percentages for the 1895 yields are based on the six yields printed in full faced type in each horizontal line. Thus if we take the average yield of all the plots of corn in 1895 as 100 we see by the table that the yield of plots 6 and 12 (averaged) on Series VII would be 114, of Series VI plots 6 and 12 (averaged) would be 88, etc.

In Table XLIV these percentages are given and also the averages of the two years 1895 and 1896. They are so grouped that under the heading of each crop (at the top of page) is shown in the left hand column of figures the yield of that crop in 1895 after each of the other crops (which are printed at the side of the page.) In the middle column the yields of 1896 after each of the other crops are given and in the right hand of the three columns are given the averages of the results of the two years.

Thus we see that, for instance, in 1895 corn after corn yielded 114, after wheat 88, after flax 79, etc. In 1896 corn yielded after corn 97, after wheat 98, etc.

In Table XLV the averages only are given and in the last column at the right the grand average of increase or decrease in the yield of the several succeeding crops caused by each kind of the preceding crops is given.

TABLE XLII.—Rotation Experiment.—Cross Rotation. The Duplicates in Table XLI are here simply brought together in averages after correcting the 1895 and 1896 yields on the basis of the 1894 yields.

Plots.	Crop.	VII.			VI.			V.			IV.			III.			II.			Plots.
		Corn '94.		Corn '96.	Wheat '94.		Wheat '96.	Flax '94.		Flax '96.	Potatoes '94.		Potatoes '96.	Mangels '94.		Mangels '96.	Peas '94.		Peas '96.	
6&12	Corn	9.6	51.9	57.2	18.7	39.9	12.6	8.3	36.1	8.0	8.2	48.6	64.1	6.2	50.3	12.0	10.5	45.7	25.6	6&12
5&11	Wheat	10.3	28.9	57.6	15.9	29.0	17.6	8.9	22.0	9.0	18.9	33.4	58.3	6.0	29.9	10.6	10.2	25.6	26.4	5&11
4&10	Flax	10.5	11.7	58.8	14.0	14.4	18.2	7.8	8.3	7.4	25.6	15.9	52.0	6.0	11.2	10.9	10.0	11.7	24.8	4&10
3&9	Potatoes	10.8	156.5	56.9	17.6	155.3	20.1	8.5	125.3	7.3	15.7	143.3	83.4	6.0	152.3	11.6	10.0	127.0	29.7	3&9
2&8	Mangels	8.7	11.2	64.4	19.2	8.8	15.8	8.5	8.7	9.4	14.9	8.4	71.1	5.6	11.8	10.4	8.2	11.8	31.7	2&8
1&7	Peas	6.9	17.7	58.4*	17.6	16.2	14.7	8.1	19.8	11.4	13.8	23.5	58.5	6.5	13.9	8.8	8.0	18.9	32.0	1&7

* Plot 7 alone used.

TABLE XLIII.—Rotation Experiment—Cross Rotation Showing 1895 and 1896 Yields in Percentages; Average Yield of Each Crop for Each Year Taken As 100.

Plot.	CROP.	VII. Corn.		VI. Wheat.		V. Flax.		IV. Potatoes.		III. Mangels.		II. Peas	
		1895.	1896.	1895.	1896.	1895.	1896.	1895.	1896.	1895.	1896.	1895.	1896.
6 & 12	Corn	114	97	88	76	79	92	107	99	111	112	101	90
5 & 11	Wheat	103	98	103	106	78	103	119	90	106	99	91	93
4 & 10	Flax	96	100	118	110	68	85	130	80	92	102	96	84
3 & 9	Potatoes	109	96	108	122	87	84	100	129	106	108	89	104
2 & 8	Mangels	111	109	87	96	86	108	83	110	110	97	110	112
1 & 7	Peas	96	99	88	89	108	131	128	99	76	82	103	112

TABLE XLIV.—Rotation Experiments.—Cross Rotation; Showing percentage yields for 1895 and 1896, so arranged that the yields of each Crop after each other crop are grouped together and averaged.

Preceding Crop.	Corn.			Wheat.			Flax.			Potatoes.			Mangels.			Peas.		
	1895.	1896.	Average.	1895.	1896.	Average.	1895.	1896.	Average.	1895.	1896.	Average.	1895.	1896.	Average.	1895.	1896.	Average.
Corn	114	97	105	103	76	89	96	92	94	109	99	104	111	112	111	96	90	93
Wheat	88	98	93	103	106	104	118	103	110	108	90	99	87	99	93	88	93	90
Flax	79	100	89	78	110	94	68	85	76	87	80	83	86	102	94	108	84	97
Potatoes	107	96	101	119	122	120	130	84	107	100	129	114	83	108	95	128	104	116
Mangels	111	109	110	106	96	101	92	108	100	106	110	108	110	97	103	76	112	94
Peas	101	99	100	91	89	90	96	131	113	89	90	89	110	82	96	103	112	107

SOME GENERAL FACTS.

This one three year trial on one field is valuable in the general results, as displayed by the left hand column "grand averages," of Table E. However, owing to a lack of perfect uniformity of soil, to the fact that different seasons and other soils and other localities in the state might show different results, it would not seem wise to use even the grand averages with too much confidence. It would be unwise to attach too

TABLE XLV.—Rotation Experiments.—Cross Rotations. The Averages from Table XLIV collected and the grand averages given in the left hand column showing the average effect each crop has in preparing the land for all crops.

AFTER.	Corn.	Wheat.	Flax.	Potatoes.	Mangels.	Peas.	Grand Averages.
Corn	105	89	94	104	111	93	99
Wheat	93	104	110	99	93	90	96
Flax	89	94	76	83	94	97	89
Potatoes	101	120	107	114	95	116	109
Mangels	110	101	100	108	103	94	103
Peas	100	90	113	89	96	107	99

much importance to the results shown in the other columns in Table XLV until further trials are made. As a method of finding the best order in which to place crops in the rotation this plan of experiment seems satisfactory.

On the average of these trials, potatoes best prepared the land for the succeeding crop, mangels stood next, corn and field peas next, wheat next, while flax was poorest in the preparation of the soil for the following crop. The crops growing after cultivated crops averaged nine per cent better than when grown after cereal crops. Field peas were equal to corn in the preparation of the land for other crops. If, as the table indicates, tilled crops add ten per cent to the yield of crops which succeed them more of the profits of the farm must be placed to the credit of the cultivated crop than the value of their immediate crop. If on the other hand flax and wheat detract ten per cent, from the yield of

the land the next year and future years, this amount must be deducted from the seeming profit on the flax and wheat. Doubtless if grass and clover crops had been introduced in this experiment still more radical results would have been shown. Diversification means little to the field when the rotation is between cereal grain crops. Cultivated and pasture and meadow crops must be used in rotation with the grain crops if we would keep our land in good condition for profitable farming. A greater variety of crops brings more live stock on the farm as animals are necessary to properly utilize many of the cultivated crops as well as the products of the pastures and meadows. Animals in turn keep more of the grain on the farm, and from all these crops they produce manure and thus the fertility of the land is kept up, or may even be increased. A start has been made at conducting an extensive line of experiments on the rotation of crops and the trial herein reported is preliminary to the more complete line of work begun on other fields at the different experiment farms.