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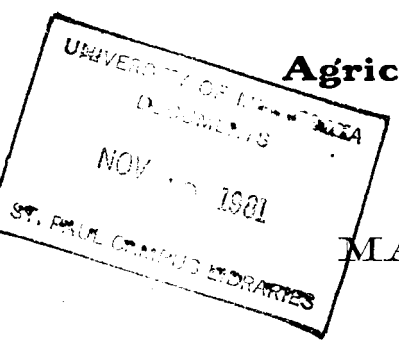

Agricultural Division.

MARCH, 1903.

REVIEW OF THE WORK OF THE NORTHEAST EXPERIMENT FARM SINCE ITS ORGANIZATION IN MAY, 1896.

ST. ANTHONY PARK, RAMSEY COUNTY, MINNESOTA.

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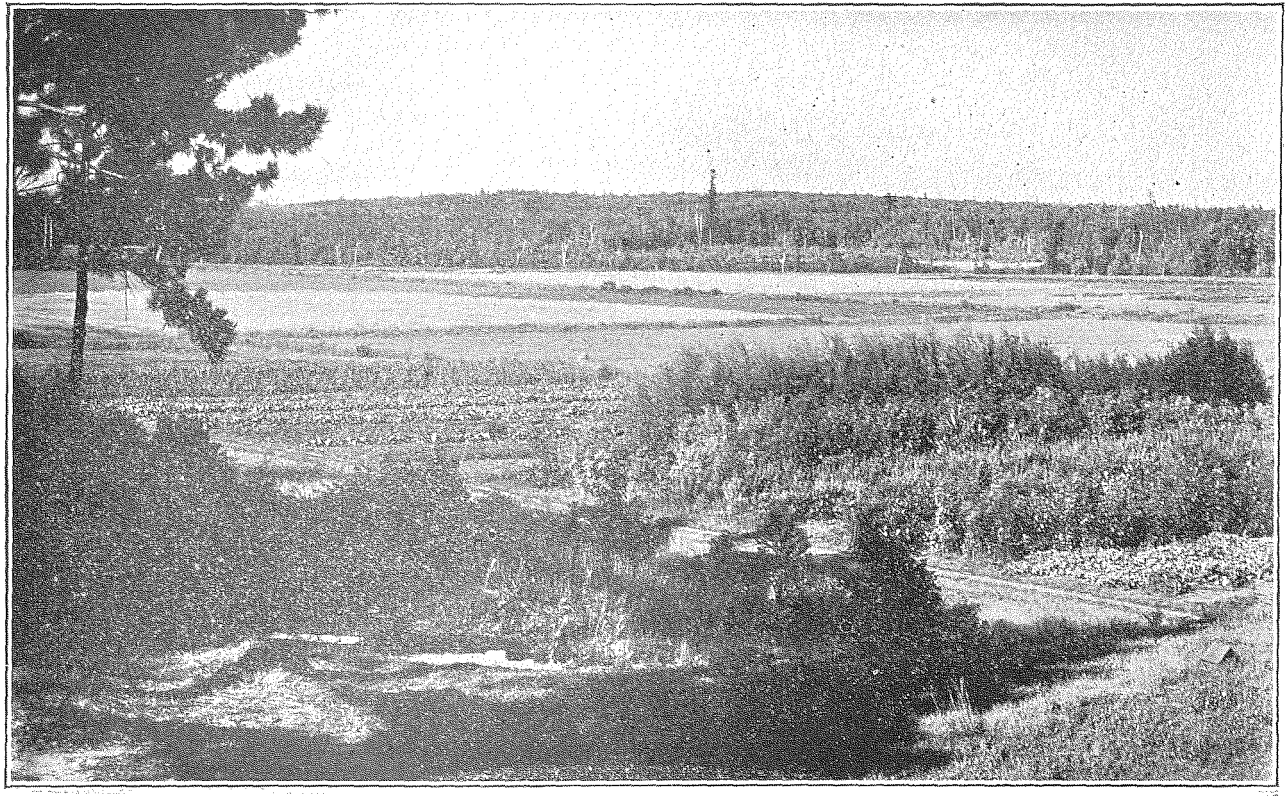


Fields and Garden, Looking Northeast from House.

REVIEW OF THE WORK OF THE NORTHEAST EXPERIMENT FARM, SINCE ITS ORGANIZATION IN MAY, 1896.

EQUIPMENT AND IMPROVEMENTS.

During the seven years from April, 1896, to January, 1903, the experiment farm at Grand Rapids has largely perfected its equipment in buildings, fencing and machinery. The original purchase included a five room farm house, a horse barn, 30x40 feet, a chicken house 20x50, ice house, blacksmith shop and pig pen. Four rooms were added to the house to accommodate the farm help. Two large machine and storage sheds were added to the barn. The chicken house which was too large for warmth was made into a shed for sheep. The pig pen was moved and remodeled. An old root cellar, which was valueless on account of the rotting of the timber, was torn out and rebuilt with stone walls and roof of cedar, making a permanent structure 25x25 feet and accessable by wagon. Near this was built a small green-house hot-bed to be used in the spring for starting early cabbage and tomato plants. Over the well a stone well-house was constructed with cement floor for churning and separating milk. A tank was set in the roof of this structure, and connected by pipes with the barn, sheep pen, and house. In the fall of 1901, a new cow barn was built, 30x58 feet, with capacity for 40 tons of hay and 25 head of stock. This with a hay shed, which will hold nearly as much, provides abundant hay room. The water works were extended to the new barn and an additional shed for machinery constructed. The stock of farm implements now contains a full line of plows, cultivators, mower and rake, grain and corn binders, separator and power, wagons and small tools.

The fencing on the farm has been quadrupled. 160 acres was originally enclosed. The acreage now fenced includes 360 acres of the 455 belonging to the farm and has been sub-

divided into pastures, fields and lanes. There is now 2276 rods of fencing of which 770 rods is 5-wired sheep fence, the rest 3 and 2 wired for cattle.

Before the state had acquired it, the farm had been considerably developed, and devoted largely to raising potatoes. Much of the land that had been cleared was brush land, and was not difficult to get into shape. The acreage under the plow at that time approximated 60½ acres. At the present time there is 112¾ acres under cultivation, from which the stumps have all been removed, making a total of 52¼ acres cleared and stumped since '96. The stumps have been pulled but not removed on 5 acres, and on 3½ acres all brushing is completed. This with 5 acres in the buildings and yards, brings the total of improved land to 126¼ acres.

Open ditches were dug to drain the low places, connecting the west side of the farm with the river on the east, the length of which aggregates 355 rods. The barnyard, sheep and hog yards are fenced with woven wire.

OATS.

The commercial grain crop of this section is pre-eminently oats. Not only is this crop necessary for horse feed on the farm, but there is a constant demand for oats as long as logging operations continue. With a necessarily small acreage on a new farm devoted to grain, it would be unwise to raise wheat and buy oats for the team. Probably nine-tenths of the grain raised in the counties of Northeastern Minnesota will be oats for many years to come.

No grain varies so in quality as oats, due to the greater or less degree of fullness of the kernel. This is affected by the season, and by the climate. Oats from northern regions are heavier than those grown farther south, as a rule. Varieties of oats differ from one another very greatly, some being much heavier and larger yielders than others, regardless of the climate or season. It costs just as much to raise a poor oat as a good one, and the difference is clear profit to the farmer. The testing of varieties of oats has therefore been one of the chief aims of the work. During the seven years, forty-three kinds have been tried. To make the test as true as possible, the kinds tested are sown side by side in

equal plots on a level piece of ground. They are kept carefully separated in harvesting and threshing and the yields weighed and compared. One season is not enough, for different soils and different seasons affect varieties unequally. But if the same kinds are tested for five years, the average result should be trustworthy. Table XCVIII shows the re-

TABLE XCVIII.—Oats, Yields of Seven Varieties for Six Years.

Minnesota No.	NAME	1896	1897	1898	1899	1901	1902	Average Yield
6	Improved Ligowo.....	38.6	65.6	61.3	43.7	37.8	51.9	49.8
23	Lincoln.....	30.0	67.6	46.3	41.9	41.6	60.6	47.2
26	Early Gothland.....	21.0	63.4	45.0	40.7	45.3	59.7	45.8
4	Early Swedish.....	37.1	53.6	49.4	36.3	42.4	55.6	45.7
35	White Russian..... ..	35.7	61.7	41.9	40.9	46.6	46.4	45.5
29	Archangel.....	30.7	50.6	52.5	36.3	42.0	58.7	45.1
32	White Wonder.....	29.3	56.1	49.4	35.3	37 2	57.2	44.1

sults obtained from the seven kinds which have been sown every year since 1896. These are the survivors of twenty-one varieties with which the experiment was begun. From these, in 1899, the Improved Ligowo was selected for seed, as showing the heaviest yield and best quality. Since 1900 the field oats raised on the farm have been entirely of this variety, and 300 to 400 bushels of seed has been sold each year. The oat is becoming widely distributed throughout the region and reports received seem to indicate that it is an improvement in many cases over those previously grown. But, as the work of the station is continuous, efforts were at once made to secure a number of new kinds for further trial, in the hopes of finding something still better. Seed was received by the aid of the U. S. Dept. of Agriculture, from Sweden, Russia, Germany, Finland and Belgium, and some Canadian oats were added, which had stood well in the tests at the Government Experiment Farms. In all, twenty were secured, which with the nine best of the old kinds, are shown in Table XCIX.

NOTE.—The yield for 1900 was thrown out as it was impossible to save all the grain in harvesting, on account of continued wet weather.

TABLE XCIX.—Oats, Yields of Twenty-Nine Varieties for Two Years.

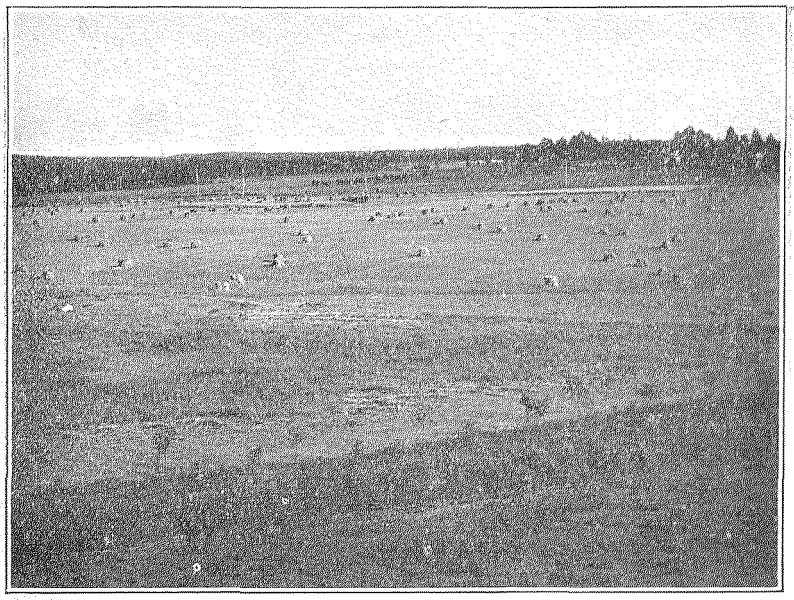
Minnesota No.	NAMES	1901	1902	Average
226	Swedish Marvel, (U. S. 617)	42.6	68.7	55.6
243	U. S. No. 5471	48.9	59.4	54.1
227	Indigene (U. S. 613)	41.1	66.5	53.8
26	Early Gothland	45.3	59.7	52.5
23	Lincoln	41.6	60.6	51.1
233	U. S. No. 2788	43.6	57.5	50.5
29	Archangel	42.0	58.7	50.4
194	Golden Sheaf	50.0	50.0	50.0
236	Strube, Germany	38.9	61.2	50.0
4	Early Swedish	42.4	55.6	49.0
252	Abundance	45.0	51.9	48.5
250	Early Blossom	39.1	55.9	47.5
256	Abyssinian	49.1	45.9	47.5
253	Golden Giant	54.1	40.6	47.4
255	Holstein Prolific	45.2	49.4	47.3
32	White Wonder	37.2	57.2	47.2
211	Silver White	44.5	49.7	47.1
35	White Russian	46.6	46.4	46.5
248	Ligowo, Agassiz	43.1	50.0	46.5
251	Wallis	39.4	53.4	46.4
237	Bull's	36.9	55.9	46.4
249	Ligowo, Nappan	47.5	42.8	45.2
6	Improved Ligowo	37.8	51.9	44 9
257	Rosedale	47.8	41.8	44.8
259	Banner	42.8	45.6	44.2
246	U. S. No. 5938	46.2	38 4	42.3
258	Lincoln, Agassiz	41.9	41.2	41.6
254	Thousand Dollar	34.1	48.7	41.4
247	Finnish Black (U. S. No. 6174)	36.9	36.9	36.9

It is evident that some of the imported varieties are of superior quality and yield and may supplant the present choice. Selection will not be made for at least another year and preferably two.

Oats are better adapted to new soil and unfavorable moisture conditions than wheat and will make a better showing when sown on breaking than will the other grains.

But it is better to plant new land to potatoes or corn fodder and follow with oats. Under such conditions larger crops are obtained. Old ground need not be plowed after potatoes or corn for oats, provided it can be worked up sufficiently with a harrow, for which purpose a disc harrow is best. If not in good condition, it is best to plow, and always in the fall if possible. An illustration of the difference in yield which may be obtained by different preparation of the soil, was given this season, when corn ground which had become compacted with the rains and grown up to some extent with timothy sods was laid off in plots and sown to oats after portions of it had been fall plowed, spring plowed, and not plowed at all. In this case it was not possible to work up the soil well enough without plowing it. The unplowed land gave 34 bushels per acre, the spring plowing 58 bushels, and the fall plowing 67.8 bushels per acre.

Oats will do well on sod, but the plowing should be done in August or early September, and care taken to lay a flat furrow, or in this climate the sod will not rot. On new land and newly cleared farms, much of the soil will be either too wet, or too raw and rooty to give best results. Under these conditions the average yield for the acreage sown may not be large. Poor seasons may also affect it. For the last seven years on the Experiment Farm, the average yield for the total acreage sown to oats was 35.2 bushels. In 1900 a severe drought, followed later by excessive rains which made it impossible to save the grain, reduced the average yield for the year to 18.7 bushels per acre. Without this year, the general average is 38.8 bushels. The variety tests have generally been placed upon soil not subject to dangers from excessive water, and these have given an average yield of 43.9 bushels, which may be considered fairly representative of the yield in good and poor seasons, on both old and new land. The largest crops have always been obtained the second year after breaking new land. In '96, land which had borne potatoes three years and was originally of the lighter, sandy character, gave 36.5 bushels. In '97, land broken in '95 and in corn the following year gave 47.3 bushels. In '98, similar land, broken a year later, yielded 52.8 bushels. In '99, a field broken in '97 and in corn in '98, gave 56.1



Oat Field.—View from House.

bushels while an old field of similar soil yielded 30.8 bushels per acre. It must not be supposed from this, that the fertility of the old fields can not be maintained—but it is true that under a careless system of cropping they will degenerate, as will any soil where sand is a conspicuous element. This same old field, which has been in cultivation since '93, gave a larger yield of oats in 1902 than at any previous time. But it has been in a three year rotation of oats, clover and corn fodder. In '96 the field yielded 36.5 bushels, in '99, 30.8 bushels, and in 1902 it gave 39.0 bushels per acre.

In 1900, much of the crop was a failure, the drought so affecting it in the early spring and summer that it produced a very thin stand and short straw. In this season there was a striking difference in the yield of different fields, ranging from 10 to 40 bushels per acre. After analyzing the possible causes, it became evident that treatment of the soil, or other superficial causes, did not affect the result in this season, so much as the natural texture of the subsoil. Those fields which yielded well were in each case underlaid with

clay at from 6 inches to 2 feet deep. This held the moisture, and long straw was formed, with thick stools. The later rains matured a good crop of oats, averaging 38 bushels. Upon the other fields, the clay lay beyond the reach of the roots, and thin stools and short straw resulted, the yield being about 20 bushels per acre, much of which was lost from inability to shock it well enough to protect from constant rain. The season of 1901 was very favorable for growth and very thick and tall straw was formed. This was the year of the memorable hot spell. The hot weather shriveled the seeds as they were filling, and reduced a yield which promised seventy bushels, down to 25 bushels per acre. The rust aided some in producing this result, as this field was low lying. A much poorer field on higher ground, which ripened a week sooner, gave 39 bushels per acre.

The time to sow oats in this latitude is much discussed. It is safe to say that late sown oats on spring plowing will never do as well as early sown on fall plowing, in a dry season. In 1902 there was plenty of moisture, and the weather while the heads were filling was cold and cloudy, prolonging the ripening for over a week. Under these conditions oats sown on May 12th gave 50.6 bushels while those sown April 18th yielded but 39.8 bushels. In an ordinary season, with dry weather at harvest, the chances are all in favor of early sowing. The grain sown in 1901 on April 25 produced 37.2 bushels, while that sown May 9th gave but 22.8 bushels. The difference in time of ripening allowed the heat and rust to affect the later sown grain, while the early sown escaped.

To test the effect upon the yield of oats, by changing seed from one locality to another, an experiment is being carried on with the Experiment Station at St. Anthony Park near St. Paul. The same variety which is being grown here continuously is also exchanged every year between the two farms, and a third sample is grown three years at each farm in succession. The experiment has run for four years. So far the grain sent here from the other farm has out-yielded the home grown plot an average of 7.9 bushels, the yields being 33.2 bushels, and 41.1 bushels respectively for an average of three years.

Wheat.—The work which has been done with wheat has been chiefly to test the capacity of the soil and climate for its production, rather than to emphasize it as a crop for export. Wheat growing for the market should logically be confined to prairies or old and well developed communities, where nearly all the land can be cultivated by machinery. In this new and uncleared section wheat can only be raised profitably on a small scale to supply a local demand. On this account the same importance has not been attached to the testing of varieties as with oats, yet 21 kinds have been tried since '96. Of these the best eleven have been grown continuously for five years, and the yields are shown in Table C. The average yield of these varieties is shown for each year at the foot of the column. The general average of 17.4 bushels is as fair a figure as can be obtained for a representative yield of wheat in this vicinity.

TABLE C.--Wheat, Yields of Eleven Varieties for Five Years.

Minnesota No.	NAME	1898	1899	1900	1901	1902	Average Yield
169	Blue Stem	19.3	13.4	12.9	26.8	24.0	19.3
146	Bolton's Blue Stem	19.3	13.0	15.1	24.4	23.0	19.0
171	Ristings Fife	16.7	12.9	15.7	19.3	25.7	18.1
51	Haynes Blue Stem	23.0	11.7	12.1	20.4	22.7	18.0
167	Glyndon 761	15.7	11.7	15.2	20.2	24.7	17.5
165	Wellman's Fife	20.7	11.4	14.7	16.0	24.0	17.3
157	Glyndon 753	16.2	12.3	15.2	21.7	19.2	16.9
181	McKendry's Fife	17.3	12.2	14.2	18.3	22.0	16.8
163	Glyndon 811	14.7	10.7	16.2	20.2	22.3	16.8
66	Powers Fife	20.7	8.7	14.3	20.2	19.0	16.6
188	Preston	15.2	13.4	13.2	17.1	18.5	15.5
	Average of Varieties	18.1	11.9	14.4	20.4	22.3	17.4

If the wheat is grown on a small scale for home consumption as flour or chicken feed, the yield is more important than the grade. The Blue Stem wheats have so far averaged better than Fife. Three Blue Stem varieties tested, yielded an average of 1.2 bushels more than the best three Fife wheats, and 1.7 bushels better than the seven kinds of Fife in a five year test.

The well known principle that wheat should be sown as soon as the ground is fit in the spring applies as truly in this section as elsewhere. In 1900 wheat sown April 19 yielded 15.3 bushel and that sown May 7th gave 12.4 bushels while the plot sown May 15th only yielded 10 bushels. In 1901, the first plot was sown April 24, and yielded 22.7 bushels, or 6.7 bushels more than wheat sown nine days later, which gave 16 bushels. The difference is not always so marked and depends much on the season, but as there is nearly always some difference in favor of early sowing, it pays to be prompt.

Wheat should not be sown on ground subject to excess of moisture, as heavy rains at some periods are apt to reduce the yield proportionately more than would be the case with oats. In '96 drowning out brought the yield down to 8.9 bushels per acre, and in '97 to 14.9 bushels due to rain in July. In '99 late sowing (May 5th) and a wet season on rather low ground produced but 11.9 bushels per acre.

Wheat is more sensitive to the fertile condition of the soil than oats. The best yields obtained on the farm were in 1898 on ground that had been broken in '95, in corn one year, and in grain the year following. The stubble was fall plowed. By this time the land was thoroughly mellow and the crop yielded 28.6 bushels per acre. Another field that had borne two crops of potatoes and had then been manured for barley in '97, gave in '98, a wheat crop of 26.5 bushels. On a third field, the wheat yielded but 18.1 bushels. This field had received no manure nor been in grass since it was broken in '93 or '94, but had been cropped to potatoes. Its fertility was thus shown to be impaired.

To sum up, sow wheat on a small scale, which will enable the selection of a fertile, well drained piece, leaving the rougher, new or poorly drained ground for other crops. Sow Blue Stem for largest yields. Sow early, on fall plowing or on potato or corn ground that is sufficiently mellow to work up with the disc harrow and springtooth; never on spring plowing if avoidable.

In 1902 4 varieties of macaroni or goose wheat were tried. They averaged 15.4 bushels, as against 22.3 bushels for the ordinary wheats. Macaroni wheats are better adapted to

dry sections and will not be apt to yield as well here as Fife or Blue Stem.

Barley.—As barley cannot be profitably raised for export in this section, for much the same reasons as apply to wheat, its principle use is as a feed for hogs. The station has tested some eighteen varieties, of the two rowed and six rowed barleys for yield. The six rowed kinds prove to be the heaviest yielders. Manshury, one of the best, averages for seven years 24.9 bushels, while Champion of Vermont, the best two rowed barley, gives 21.6 bushels. Omitting the last three years, in which the tests were interfered with by unfavorable conditions, these averages are respectively 30.7 bushels and 25.4 bushels. For the four years 1896 to 1899 inclusive all the varieties tested averaged 24.6 bushels. Three crops were upon old ground, and the fourth was injured by water. The best yield was obtained in a field test in 1898, on new land broken in 1896 and planted in 1897 to squash. The ground was fall plowed and yielded 41 bushels per acre.

In 1900 barley sown about May 1st suffered from drought, yielding from 13 to 17 bushels, while that sown later, or on May 15th, received sufficient benefit from late rains to mature a crop of 27 bushels. In 1901, the plots sown on low ground were drowned out, yielding 12 bushels, and a field on higher and lighter soil gave 25 bushels per acre.

The field chosen in 1902 for the barley varieties gave interesting results. This field has been cropped since 1894, and had borne three crops of potatoes, two of grain and one of cornfodder. It was manured in 1898–'99 for the corn. In 1900 it was seeded down, but being a droughty field and in poor condition the dry weather burned out the grass. In the fall rye was sown, and in 1901 this was pastured off and corn planted which was also eaten off by sheep. The land was fall plowed and sown to barley. A dry spell after the grain was up, thinned out the straw on all the grain fields but later favorable weather matured a large crop of oats and wheat. But the barley on this field did not get moisture enough to form its straw and the crop averaged 8.4 bushels per acre. Clover seed sown with the grain flourished amazingly with the thin stand of grain and later rains, and furnished the means both to bring up the fertility and supply

the moisture holding humus, of which the soil on this field had been too far depleted.

Experiments on the best time to sow barley have been interfered with by other causes and have not given conclusive results. Danger from frost would not permit sowing much before May 1st in an ordinary season.

The season is sufficiently long to ripen all grains before frost. The following table gives an average of the actual dates of planting and harvesting grain, if the grain is cut when ripe, for seven years on the experiment farm.

Kind.	Sown.	Ripe.	Growing Period.
Barley	May 1st.	Aug. 1st.	93 days.
Oats	April 25th.	Aug. 12th.	109 days.
Wheat	April 25th.	Aug. 16th.	113 days.

On several occasions, the oats were sown first for convenience, and at other times they ripened proportionately later than wheat on account of being on lower ground. A slight correction can be made to bring the facts more in accord with a probable average, as follows:

Oats	April 25th.	Aug. 10th.	107 days.
Wheat	April 22nd.	Aug. 15th.	115 days.

Winter Wheat.—Two plots of winter wheat were sown in the fall of 1900, but owing to poor preparation of soil, the crop was injured, though the wheat lived over winter, and yielded but 7 and 10 bushels. In the fall of 1901 the seed saved was sown, together with fresh seed of the same two varieties, on Aug. 28th. The crop was not injured by the winter, and ripened July 31st. The seed from the defective plots of the preceding year yielded an average of 18.1 bushels per acre, while the new seed gave 22.9 bushels, or 4.8 bushels better. The wheat was of very good grade. In both seasons there was sufficient snow to furnish protection during the winter. This snow-fall, which the protection of the timber allows to settle evenly on the fields, is the cause of the success in growing winter wheat in this latitude, when it cannot be grown much farther south for winter killing. It is not safe to sow much later than Sept. 1st for the wheat will not have time to grow in the fall sufficiently to form hardy roots.

Speltz is attracting some attention as a grain for feeding

stock. The kernel resembles wheat but the husk adheres so closely that it cannot be separated in threshing and must be fed whole. It has no marked advantages as a feed over barley or oats, and unless the yield is greatly in excess of these, there is no reason for substituting it. So far the trials of speltz on the farm have not been encouraging. In '96 it yielded 11 bu. per acre on a low price. In 1902 the yield was correspondingly poor. When the conditions under which it is grown are more favorable, the station will be in better position to report upon speltz, but it is well to go slow on a novelty until it is proved to better than what already exists.

Winter Rye has been sown for six seasons and has never been injured by winter killing, not even in '97-8 when the clover was injured. It may therefore be considered a perfectly safe crop for this section. The rye sown has generally been either pastured or cut for hay. In 1902 that which was threshed gave from 25 to 30 bushels per acre. The field yielded 24.7 bu. while the average of five plots was 30 bu. The only things to be avoided in growing rye are standing water in the fall, and late sowing. Late rains injured the crop of '99 and '00, greatly reducing the yield. As rye grows vigorously in the poorest soil, it should logically be placed upon well drained and light land, both to escape the water and to make the best use of such soil. In this latitude rye may be sown, and has been sown for six years, as early as Aug. 15th, with no danger of its getting past the stooling period before winter. The plots sown in the fall of 1901 were at different dates, ten days apart to test the effect of late sowing on yield. The results were not uniform, the largest yield being from that sown Sept. 16th, after which there was a drop. But it was shown that rye could be sown at any time between these two dates, Aug. 15th–Sept. 15th, with success. One and one-half bushels of seed were used. If pastured, either for cows or sheep, it should be done before the shoots appear as it then matures rapidly and becomes woody and unpalatable. This date is here about May 12th. By the 18th it is apt to be too late for pasturing. If cut for hay it will be ripe about June 10th and will give 1 to 1.5 tons per acre. It makes good hay but at this season the

weather is apt to be unfavorable for curing. The best uses are therefore as a grain, or for pasture. Needless to say, one cannot pasture rye in the fall and spring and then expect a grain crop of any size from the same piece. The further south the locality the later may rye be sown, and the earlier it will be ready for pasture or ripe.

Flax has been raised successfully, but prefers a heavy soil or new land. The chief objection to raising flax is the difficulty of marketing it in less than carload lots.

Buckwheat, if sown about June 1st ripens and produces a fair crop.

Beans if planted on a warm soil about May 20th, and well cultivated, will usually get ripe if early varieties are used.

Grasses and Clover.—Grass is the most important crop of this section, both from a financial standpoint and from that of proper farm management. Stock raising is largely dependent on it, and the utilization of wild land and processes of clearing are closely concerned with the uses that can be made of grass. Natural meadows are found along water courses and to some extent about lakes and sloughs. Occasionally they are of great extent and very valuable furnishing a source of hay which makes the raising and wintering of considerable stock possible almost at once. On the whole such supplies will tend rather to diminish than increase as the land is opened and drained and the surface water dries up.

The second source of supply is sought by pasturing, and seeding down for this purpose, upland which may or may not have been cleared and brushed. This brings into use the tame grasses. The success obtained in securing a catch, and a crop of grass, on such wild land, will depend upon the kind sown, the character of the soil, the amount of brush and sod, the preparation of the soil and the time of year sown. It is evident, that no general rules can be laid down nor can definite results be depended on. Merely scattering the seed will not always pay, though it requires the least expense. The nearest approach to success by this method is obtained on clay or heavy soils which have recently been heavily burned, killing most of the underbrush and leaving a coat of ashes on the surface. Thick underbrush

prevents grass from getting a start. Sometimes this may be destroyed by burning, but with the risk of doing damage both to soil and surrounding timber—of which risk the operator must be the judge. If the brush is thick and cannot be burned it must be mowed, preferably in June, or pastured off with sheep or goats, before a stand of grass can be secured.

On lighter, sandier soils, badly burned, and easily cleaned up of trash, grass may be sown broadcast. The stand will depend on the poverty of the soil, the amount of damage done in the burning, and the dryness of the season—and on such soils, will not generally be very successful.

Preparation of the soil increases the prospect of a good stand of grass, in proportion to its thoroughness. On rough stumpy ground, scratching with a V shaped spike tooth drag, or with a spring tooth, helps to tear up the surface and gives the grass a chance to get a foothold. Thorough pasturing by sheep, followed by such dragging produces still better results. But in general it is not well to expect too much with too little effort, and permanent grass land cannot be hoped for until the soil is broken and subdued.

Such seeding should be done in the spring, and as early as possible, preferably before the frost is all out, if the soil can be worked up on the surface. The kinds of grass most adapted to such seeding will be considered after a discussion of the results obtained on the farm in testing grasses.

The third and ultimate source of grass must be the raising of tame hay, on improved land, and consists in seeding down land that has been broken and has raised a few crops as potatoes, cornfodder or oats. By this means the soil is worked up, all brush and wild plants killed out, it is improved in surface drainage, is more level, and will be in condition to devote its entire growing energy to the grass. In return the grass roots fill the soil with a store of decaying fibers or humus.

The comparative value of different grasses can best be noted under these conditions, when they can reach their best productiveness. Soil and moisture conditions influence yields very greatly, and the character of the season as to distribution of rainfall sometimes reduces the crop one-half or doubles it.

In '96, plots were sown on soil of light sandy character that had been cropped for three years in potatoes. Table CI gives the yields of these plots for the three following seasons.

TABLE CI.—Yields of Grass and Clover Plots, Sown in 1896. Continued Three Years.

Plot	KIND	Date Sown	'97 Yield per Acre	'98 Yield per Acre	'99 Yield per Acre
			Tons		
1	Red Clover	May 11, '96	2 30	Plowed	
2	Alsike Clover	"	2.15	Plowed	
3	Timothy	"	.75	.61	.85
4	Red Top	"	1.00	.95	.93
5	Agropyrum Tenerum	May 1, '97		1.91	.70
6	Bromus Inermis	May 11, '96	1.08	1.18	.52
7	Orchard Grass	"	.03	.07	.27
8	Alfalfa	May 1, '97		.00	.00

In 1900, grass plots were sown on a soil of a lower, wetter character, underlaid with clay. The yields for two years appear in Table CII.

TABLE CII.—Yields of Grass and Clover Plots Sown in 1900, Continued Two Years.

Plot.	KIND	Date Sown	Yield per Acre, tons	2nd Crop	Total per Acre	Per cent of Other Grasses	Yield per Acre, tons	Per cent of Other Grasses	Corrected Yield
			'01			'01	'02	'02	
1	Timothy	Apr 23, '00	1.30			0	2.22	0	2.22
2	Red Top	"	1.20			2	2.12	0	2.12
3	Bromus Inermus	"	.85			10	1.40	5	1.33
4	Perennial Rye Grass	"	.65			80	1.00	80	.20
5	Orchard Grass	"	.25			70	1.18	95	.06
6	Mammoth Clover	"	2.45			0	2.85	10	2.56
7	Red Clover	"	1.90	.67	2.57	0	1.60	90	.16
8	Alsike Clover	"	2.45			0	2.83	10	2.54

In the spring of 1901, twelve plots were sown on a field that had been broken in '97 and cropped for three years in potatoes and other annual crops. The soil was silty loam, well mixed with humus and underlaid with clay at 12 to 18 inches. The yields of the varieties, and mixtures sown, for 1902, are given in Table CIII.

TABLE CIII.—Yields of Grasses, Clover and Mixtures, Sown in 1901.

Plot	KIND AND MIXTURE	Am't Sown pr Acre	Date Sown	Pr. Ct. in Crop	Yield Pr Acr '02	Second Crop	Total Yield '02
1	Red Clover	10	Apr 29,'01	100	3.26	.74	4.00
2	Alsike Clover	7	"	100	2.93		
3	Mammoth Clover	10	"	100	3.89		
4	Timothy	10	"	100	2.17		
5	Red Top	7	"	100	2.63		
6	Timothy Bromus	8 8	"	90 10	2.58		
7	Red Clover Timothy	6 9	"	75 25	3.13	.78	3.91
8	Red Clover Bromus Timothy	5 8 5	"	88 2 10	3.48	.76	4.24
9	Red Clover Timothy Red Top	5 5 4	"	80 15 5	3.72	.65	4.37
10	Alsike Clover Timothy	5 9	"	60 40	2.80		
11	Agropyrum	20	May 2,'01	100	2.35		
12	Agropyrum Red Clover	15 6	May 9,'01	10 90	3.50	.76	4.26

The plot tests as shown have been confined to the clovers red, mammoth and alsike, and the grasses, timothy, red top, bromus inermus, orchard grass, rye grass and agropyrum. Small garden tests have been made of other kinds, but none have given promise sufficient to warrant their use in preference to the above. Neither rye grass nor orchard grass have shown any valuable qualities. The yield of orchard grass both in tables CI and CII is seen to be nearly nothing and the plot is soon invaded by other grasses. Orchard grass appears to have some value as a lawn grass, as it catches and forms a sod, but it does not produce hay. Bromus inermis, or brome grass, which has been widely recommended for dry sections with good soils, has not been a success when sown alone, in the trials thus far made. It is not a complete failure, like orchard grass, but it does not thicken up to produce a large crop. It would be of more possible use on droughty soils than on low soils well supplied with moisture. For instance, in Table CI the yields on old land, sandy and rather dry, averaged for three years .93 tons against .74 tons for timothy, while in Table CII on lower and better

soil, timothy for two years gave 1.76 tons and bromus 1.15 tons, or about 64 per cent. This fairly represents the relative value of the two grasses on soils adapted to timothy. The comparison on sandy soils is probably in this case a little too much in favor of the bromus. Bromus when sown in a mixture, with timothy, will persist from year to year, but will not increase, to form a very large portion of the crop. While the seed remains expensive its usefulness is limited in this region, though it might be tried on a small scale for pasture mixtures.

Timothy through the cheapness of the seed, and good quality of hay for horses, is the most universally used of any grass. But no grass depends more on the moisture and fertility of the soil, for the production of a good crop. The ideal soil for timothy is quite moist, rich clay or loam. Impoverished, sandy or droughty soils produce very light crops. Witness Table CI on soil that had been in potatoes three years, where the timothy gave an average for three years of but .74 tons. In Table CII the average, on low soil well supplied with moisture, is 1.76 tons for two years, while in Table CIII, on new land, low, and five years from breaking, 2.17 tons were obtained in 1902. Timothy will do well on all land adapted to grass, but on land that is sandy, hilly and droughty, good results will not be obtained in all cases.

Red top has compared favorably with timothy in all of the tests, as the tables show. It flourishes best on moist land, and is a valuable addition to a mixture for meadow or pasture, with timothy. Agropyrum, or slender wheat grass has been tried twice, with the plots. It produces a slim stalk without much foliage and a wiry rather impalatable hay. The yield is fair compared with timothy and it will be tested further, especially on poor soil.

The results obtained with clover are the most striking, and important, of all the work done upon the Experiment Farm. Clover has the power of restoring fertility to worn out soils, by taking nitrogen from the air and storing it in its roots. If clover can be grown with certainty, it will make the difference between success and failure on much of the lighter land. The growing of clover on the farm has been a success from the first year. In seven years there has

been but one complete failure, caused by killing out in the snowless winter of '97–'98, when similar results were obtained all over the state. More important still, the clover seems to do well upon the lighter soils as well as the low and heavy fields. In table CI, 1897 with timothy yielding .74 tons, Red Clover yielded 2.3 tons per acre and gave in addition a second crop.

In 1899, 26.9 acres sown to clover gave 64 tons, or 2.42 tons per acre. The winter of 1899 and 1900, and the drought in spring of 1900 injured the clover so that there was very little in the first crop, but curiously enough, it came in after the first cutting of the meadow, and produced a very fair second crop.

In 1901 11.8 acres produced 19.5 tons of clover or 1.68 tons per acre. Eight acres of this was rough, rocky and a part of it swampy. In 1902, 22.1 acres were in clover, and the crop yielded 46.5 tons an average of 2.10 tons per acre. In 1900 the drought injured the catch on one field and it was plowed up, but other fields sown this year gave in 1901 from 1.4 to 3.3 tons per acre of clover. Thus out of six crops there has never been a failure to catch, and but one complete crop failure due to winter killing, and one partial one from drought. The four full crops averaged for all fields and all four seasons, 2.13 tons per acre for the first crop. The second crop has averaged about .75 tons, but has not always been cut.

In the comparison of red clover with mammoth and alsike clover, the second crop, and the subsequent yields must be considered. Red clover will, as shown, produce a heavy crop the year following the seeding, and in the fall of the same season will give a second cut of a ton or less. This practically exhausts it for hay, and there will not be a crop on the land the next year. There may be considerable clover, but it will be scattered and thin. The root of each red clover plant lives usually for but two seasons, and whatever clover appears the third year is the result of natural seeding. Not cutting the second crop but pasturing it, will as this crop generally bears the seed, result in more clover appearing in the meadow next year, but the main crop will even then be the other grass sown with the clover, or lacking this, wild grass

or weeds. Mammoth clover grows to a larger size than common red, ripens later, produces more hay, but does not give a second cutting, and one season usually exhausts it as with the red. Alsike clover is of finer growth than red, does not produce as much, though yielding well, and gives but one crop in a season. It thrives on wetter soil than red clover, and it is more persistent in nature. The comparative yields of these clovers under best conditions are shown with great fairness in table CIII. In table CII the red clover plot was injured by water. Table CI gives a fair comparison of red and alsike on poor soil. Ordinarily the test on such land would be more in favor of the red. The perennial nature of alsike when protected in winter by sufficient snow was well shown in 1901-1902. A field that in 1901 gave 1.6 tons alsike per acre, yielded in 1902, an average of 2.5 tons, with a more favorable season, nearly the whole crop being alsike. In the plot test in table CII alsike sown pure, gave a heavier yield in 1902 than the first season. In this test, mammoth clover, which had been cut late the preceding year, also came on and gave a large yield. But the red clover plot was overgrown with foreign grasses.

Alfalfa has been sown in three trials using hardy varieties but has never survived the winter. With clover so certain, it will not pay to experiment with alfalfa in the face of these results.

Taking up the subject of seeding brush-land, we must consider blue grass. This grass is nowhere in the state sown for hay, but in the southern portion is sown, or spreads, into pastures, and in time crowds out everything else. It produces pasture up to about June, but during July, Aug. and part of September there is practically no feed furnished by it except dry stalks. Its only possible use is in permanent pasture. The trials so far made, while not extensive enough for conclusive results, indicate that in this latitude the grass is of very little use even for pasture. It produces but scant feed and takes up the ground in place of other grasses. Its use should be restricted. The widest dependence must be placed on timothy, and for general seeding this may be mixed with red top using about one-fifth of the latter. It will probably pay to add clover on ordinary soils and especially

clays, and alsike on wet lands. Bromus would be worth trying in dry soils but it is difficult to cover and obtain a catch, on brush-land, and the seed is expensive. Other grasses have no proved value. Bearing in mind the biennial nature of red clover and the expense of the seed, the quantity sown with timothy for brush pasture should not be large. A good general rule would be six quarts timothy, one quart red clover, one quart red top per acre, which is 9 lbs. timothy and 2 lbs. clover, the weight of red top depending on its freedom from chaff.

For meadow on cultivated land, red clover and timothy should always be sown together. Alsike may be substituted on low ground. The clover will make almost the whole crop the first year, except when injured, when the timothy will take its place. The second season which is the third after sowing, timothy will make the bulk of the crop.

The subsequent treatment of the meadow determines the character and in a large part, the success of the farming in this region. It is natural for many reasons, to wish to have this land in meadow as long as possible. No labor is required but the haying, and more time can be spared on other work, as clearing. Again, when stumps have not yet been removed, plowing is difficult and slow. But against this is the fact that timothy will not continue to yield well on any soil, for a number of years, as the sod becomes tough and prevents the growth of new grass. On low soils the decrease will not be so rapid, but on light soils, the third year will sometimes see a diminution of the yield to a point where it would hardly pay to cut it. If meadow land is left in grass, the plowed land will be plowed every year for oats or potatoes, and its original stock of humus and fertility sadly drained. All the crops will suffer. The tendency will be to get everything into grass, and to work away from home as much as possible, instead of putting the time and work on the farm, and making it produce the living. If it is clearly recognized that sod should never be left more than two or, at most, three years, stumps will come out sooner, mowers and rakes will take the place of scythes, grass seed will always be sown with grain, and grain and cornfodder can have the benefit of fall plowed sod. The crops will be doubled, the fertility of

the land restored and retained, and a permanent home assured. Plow your sod. If the pressure of work is such that it cannot be done the second or third season let it be regarded as an error, to be remedied at the first opportunity, but never think of land seeded down as "taken care of" indefinitely.

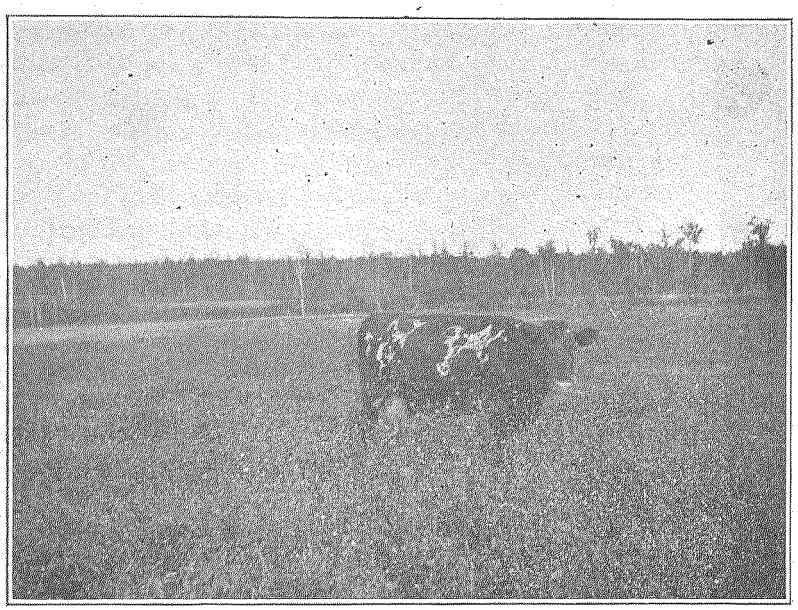
On the Experiment Farm sod has never been allowed to lie over three years. On the lighter soil the second crop of clover has often been plowed under or the sod fall plowed the first year. The only field that has lain three years is a low rich piece of bottom land. The first year it yielded 2.9 tons of clover in the first crop, and a good 2nd crop. The next season that of 1900, the drought cut down the yield of timothy to about 1 ton per acre. In 1901 the field gave 1.91 tons timothy per acre and was then fall plowed for corn-fodder. On other fields the yield of timothy the second year has dropped to 1 ton or as low as .75 tons per acre, and if not plowed, would sink still lower. One of the poorest fields, rocky and partly swampy, which gave in '97 a good crop of clover, yielded in '98 .75 tons timothy. The following year this was pastured, and fall plowed. Grass and clover was sown with oats in '00, and in '01 the average yield for the whole field including bad spots was 1.47 tons clover per acre. It was pastured in the fall, and in '02 gave 1.02 tons per acre. It is safe to say that more grass was produced on this field than if it had been left in grass continually and the oat crop was raised in addition. Timothy will seldom exceed two tons per acre, while clover, with both crops will often go over four, but only when newly sown. A meadow fall plowed and sown to oats and clover will produce as much hay the second year as if left in grass for the two years, and will also give an oat crop, and the ground will then be richer for the clover, and the meadow renewed. Examples of clover yields have been given in general averages. The best fields have gone as high as three tons for the first, and one ton for second crop. In '98 a small field yielded 3.33 tons per acre. The second crop was fall plowed. In '02 a field of 10.3 acres gave 25.8 tons of cured clover, which would have been heavier if the hay could have been cured more rapidly. This field in the fall cut 10.3 tons of well cured second crop clover

from 7 acres, which grew to a height of 24 inches. Next year this field will yield largely timothy, and will not be left in grass longer than two more seasons. One of the oldest and longest cropped fields has been seeded down three times, the first in '96. The clover crop of '97 gave about 2 tons per acre with a good second crop. This field had been cropped to potatoes three years previously and was sandy. In '98 the timothy yielded but .75 tons and would have continued to yield poorly if left in grass. It was plowed for grain which in '99 gave 36 bushels per acre, and again seeded with clover and timothy. The drought in 1900 prevented a good crop on this light soil, by spoiling the clover stand. A portion was fall plowed for corn. The rest of field yielded in '01, .91 tons timothy, and was then fall plowed. In 1902 this field gave 39 bushels oats per acre, and an excellent stand of clover was secured for 1903. The crop of cornfodder raised on the sod in '01 went five tons of cured fodder per acre. Thus in spite of a failure of the stand in 1900, spoiling one of the two clover crops, the field has continued to produce good crops of grain, cornfodder and grass, solely through the rotation of the crops and the benefit the soil obtained from the decaying sod and the fertility added by the clover. No manure has been put upon the field since '95.

In seeding, the usual amounts used have been clover 3 qts., timothy 6 qts., or 6 lbs. and 9 lbs. respectively. As oats have been the chief grain crop, the grass seed has usually been sown with oats, though wheat or barley are in some cases better nurse crops. The seed may be broadcast and harrowed in, after the grain is sown. Both should be sown as early as possible. The average date of sowing grass seed on the farm for seven years, for all fields and seasons is April 26th, and it is planned to sow as early as the 18th or 20th if possible.

In haying, it is the aim to cut clover as nearly as possible at the period when about half the heads are brown. This date, for seven years has fallen between the 12th and the 18th of July, averaging about July 15th. Timothy, when pure and heavy, ripens three or four days later. The second crop of clover is fit to cut about Sept. 12th to 18th. Its weight depends not only upon the season and the soil,

but bears a direct relation to the time of cutting of the first crop. It starts to grow with great rapidity when the first crop is cut. The earlier this is done the heavier will be the 2nd crop. In 1902, a field of clover was cut July 16th, and yielded 2.5 tons, while the second crop gave 1.5 tons. On the same field, a plot was cut for the first crop, 9 days later, or July 25th, and gave 3.25 tons. This plot yielded .75 tons second crop. Roughly speaking, what is lost in weight by early cutting of first crop is made up in the second crop. This second crop of clover is of great value to the farm, as it can be turned to whatever use the needs of the farm demand.



Second Crop Clover for Pasture.

It is unexcelled as fall pasture, lasting till well along in October or after heavy frosts. On land lacking humus, or droughty it can be plowed under and will add immensely both to the fertility and drought resistance of the soil. In a season that threatens a wet fall, it is best to devote at least part of it to one of the latter uses, to avoid the danger of its spoiling from continued rains before it can be cured. In 1899

one field of 3.37 acres was cut in the fall and gave 1.15 tons per acre. On a second field of 15 acres, a portion was cut, a part pastured, and the rest plowed under. The year following, the land that had this clover plowed in yielded 35 bu. oats and 14.5 bu. wheat, with a good development of straw in spite of the dry spring, while on some other fields the straw was scarcely long enough to harvest and yield very low. A part of this difference at least, should be credited to the clover. Again, in 1902, two fields, or about seven acres were plowed under about Sept. 5th when the clover was one foot to 18 inches high. Another field of 2.5 acres pastured 75 sheep from Sept. 19th to Oct. 6th, furnishing in that time about two-thirds of their feed. A fourth field of 10.3 acres was divided, seven acres, already mentioned gave 10.3 tons of clover. The other 3.3 acres pastured 12 head of cattle from Sept. 15th till the second week in October. They ran in it after this date.

Clover will often grow with such luxuriance in the year it is seeded that it produces a large amount of foliage by fall. If stock are allowed to run on this during August and early September when the clover is getting its strength and storing up food in its roots for winter, with which to make the growth of the following spring, it cannot help but greatly damage if not utterly ruin the prospects of a crop. The leaves are the lungs and stomach of the plant and it cannot grow without them. But it is reasonable to suppose that after the middle of September, or later, the functions of the leaves have to a certain extent been performed, and it may be a matter of economy to pasture them off rather than let the frost harvest them. But rather than create the impression that this fall pasturing can do no harm, at any time, it would be better to take an absolute stand against it. Practice indicates that very late pasturing of very heavy seeding is not detrimental. The field which gave the heaviest yields in 1902, was pastured in the latter part of Sept. 1901, by cows, for three weeks, evidently with no evil results. Further experiments are being conducted along this line.

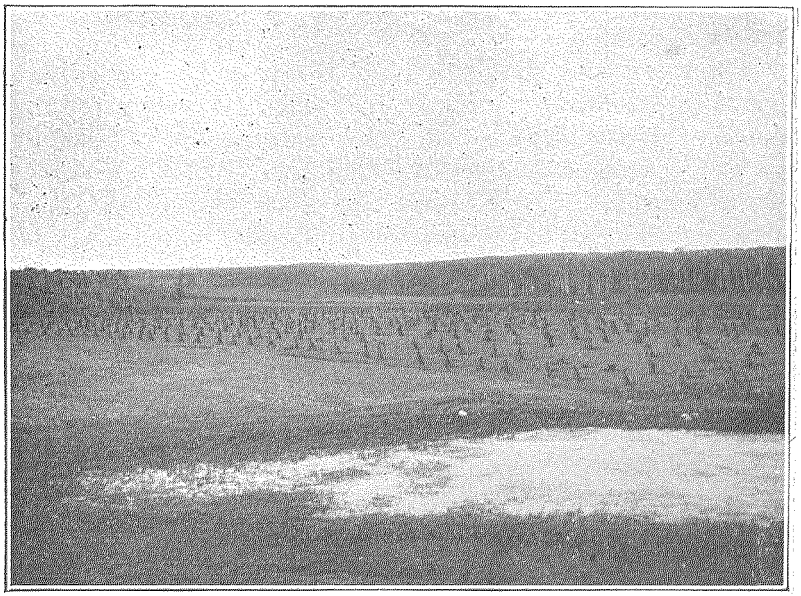
Clover, while so valuable a crop, both for its first and second crop, is not so easily cured in this latitude as could be wished. Promptness, and the cutting of the hay in cloudy

weather, to take advantage of all the heat and sun possible in curing, combined with tedding or pitching over in the swath, will usually save it in fair condition. The second crop should be cut in wet weather, rather than in dry, that it may be partially cured when the drying weather comes. Occasionally some has been lost, in a continued wet fall, but in 1902 it was saved in fair condition, after curing in winrow and cock for eleven days. In curing timothy, no difficulty need be experienced.

The work done with grass and clover on the experiment farm is by no means complete. In Table CIII were given the results of twelve plots, six of which are mixtures of different kinds of grasses and clovers for meadow. In 1902, twenty-two different plots were sown, of grasses, clovers and mixtures, including all of the varieties previously tested, and blue grass. These are so arranged that one-half of each plot can be cut for hay and the other half pastured by sheep. This will test the grasses and mixtures in two distinct ways, which will be a check on each other, and are sure to give useful results. The amount of seed to sow of clover and timothy, and the proportions of timothy and red clover seed best adapted for general seeding have been tested in a series of 22 plots sown in 1902. Results from these tests will be available next year.

Cornfodder.—It is no longer considered good agricultural practice, anywhere in the corn belt to grow corn with the intention of feeding the stalks to cattle after a crop of ears has been removed. The ears absorb most of the feeding value of the corn, and the remaining stalks are dry, woody and tasteless. But cornstalks were never more widely used than today, as a feed for stock. They are grown for this purpose alone, and sown thick, in rows, which prevents the formation of ears and allows the food material to remain distributed through the stalk. Here in northern Minnesota the reasons for growing corn for seed and fodder separately apply with still greater force than elsewhere. The kinds that will ripen seed are necessarily small in size, and the fodder that would be obtained from these stalks would hardly amount to a ton per acre of poor feed. But it requires much less time to mature corn for fodder alone and in consequence the same varieties

can be grown here for this purpose, as are grown in southern Minnesota, and nearly as large yields obtained. Cornfodder, grown in this way, becomes second only to hay in importance to the farmer in this section. In one way it is superior to hay. A bad season may materially reduce the hay crop, but with proper care and cultivation cornfodder can be



Cornfodder, Looking Southeast from House.

almost absolutely relied upon for a yield which will furnish ample food to take the place of hay. It thus gives to the dairyman and stock feeder a permanence and security which is of untold value to him. Cornfodder has been grown every year on the experiment farm and has never failed to yield well. Records were not kept of the yield of the fields for the first four years, but in 1900, when the hay crop was cut down by drought to less than a ton, a field of 3.1 acres gave 14.4 tons of cured fodder, or 4.67 tons per acre. In 1901, 39.2 tons were cut from 7.75 acres or 5.05 tons per acre, and in 1902, in a very cold and backward season, it still gave 3.9 tons per acre. The value of cornfodder was especially shown in 1900, when, in addition to the field mentioned, a second

field was sown as late as July 3rd, or after it became evident that the hay crop would be very short. This field of 3.2 acres gave 8. tons of cured fodder when cut Sept. 10th, or 2.5 tons per acre. The following winter, cornfodder was the chief reliance for the cattle, and it has always been extensively fed to the herd in place of the hay which can be sold for a good price. The yield per acre will depend somewhat on the kind of corn used for seed. If the small flint or very early dent kinds are planted for fodder, the yield may not be more than half what it would with larger dents. In '96 this was shown in a test of varieties, when the medium yellow dent known as Minnesota No. 13, gave 7.3 tons, and Squaw corn yielded 4 tons. This difference in yield is worth securing. Any dent that will mature in southern Minnesota or northern Iowa is suitable for fodder in this section. Very late and large kinds, as Giant Fodder, are not recommended, as they do not mature sufficiently during the growing season, and produce too coarse a stalk. In this connection, the time of planting, and method are quite important. The

Cornfodder, Lower Field.

corn, to make good fodder, should be ripe enough for the lower leaves to turn yellow. This result cannot be attained with the very late southern dents, and the fodder will be watery, sour and hard to cure. Dents from southern Minnesota will easily mature to this extent if planted at the right time. The date of planting on the farm has varied from May 31st to June 10th. The length of the season will depend on the frost in the fall. Should the corn freeze before it is cut, it is greatly damaged, and its flavor and feeding value reduced one-half. This freeze in seven years, has never come before Sept 7th, and the average date has been Sept. 14th. It is not safe then to delay starting to cut much after Sept. 5th. The earlier the corn is planted the sooner it will reach the desired state of maturity, and the more time there will be to take care of it before frost. While June 10th is not too late, it can be profitably sown as early as May 25th. If emergencies arise demanding the planting of late corn, as occurred in 1900, a crop may be secured as late as July 1st. It stands to reason that in planting at this date, better matured corn, and possibly just as much of it, can be raised from the seed of earlier flints or dents.

The method of planting has much to do with the size and quality of the crop. Planting in hills for fodder should be absolutely abandoned. The stalks are large and tough and yield low. Broadcast planting is often adopted, on the ground that it does away with cultivation and saves work. But the increased labor of cutting must be considered, and the results from broadcasting are very unsatisfactory. Weeds grow unless the stand is thick, and when it is, so many stalks are produced, that very often the moisture gives out before the crop is more than well started, and short sickly stalks result, difficult to handle, and with a total yield not equalling that obtained by planting in drills and cultivating. In proof of these facts, the plot planted in 1902, in hills, gave 2.4 tons, that sown broadcast produced 3.7 tons, while the drilled and cultivated plot yielded 5.4 tons per acre, or nearly one-third more than broadcast. Cultivation kills the weeds and prevents evaporation, so that all the moisture and fertility in the soil go to developing the crop. On a weedy piece this is especially important. In 1900, the plot sown broadcast,

gave 4.7 tons, nearly one half of which was weeds, while on the cultivated plot 5.25 tons of clean fodder was cut. If it is not possible or convenient to plant so as to admit of cultivation, one must not blame the corn, or the soil, for poor results. Three and one-half feet is far enough apart for cultivation and proper development. The seed may be sown with a grain drill if one is available by plugging most of the tubes, or with a common garden seed drill. It should be sown so that the kernels are not more than an inch apart in the row. This will take a little over a bushel of seed per acre. This close or thick planting insures small stalks, which the cattle will eat clean, and thus makes the whole crop available. The wider apart the stalks are in the row, the coarser they are, and the greater the waste in feeding.

Cornfodder will grow upon new land, and may even be sown in the furrow, in breaking, though it will not give its best results under such conditions. Still, if the soil is thoroughly worked down and does not dry out too much the yield will be fair. The yields are greatly increased by manure, which may be freshly applied in any quantity without injury. On worn soils the effect is striking. A sandy piece which had been cropped since '94 without manure, produced in 1901, a crop of 3.7 tons, while on the same piece in that year an application of 10 tons per acre of manure gave a crop of 6.84 tons, or an increase of 85 per cent. This same plot was again manured, and in 1902 yielded 5.44 tons while that not fertilized gave 2.65 tons, a difference of 105 per cent. The falling off in total yield for the plots for the preceding year was due to the season, which was one of the most cold and backward ever experienced. Cornfodder will also do well on sod land, but it should be fall plowed. In 1898 the crop was planted on spring plowed sod, and while it gave a good yield, the crop was not over half what it ought to have been, though exact figures were not obtained. The sod was not decayed and the corn suffered from lack of moisture. In 1901 this same field was planted to cornfodder on sod plowed the preceding fall. The yield was 5.05 tons per acre, due largely to the effect of the rotting sod. The field had been cropped without manure since '95, and its fertility maintained by the rotation

of grain crops, with grass in short periods. Where possible cornfodder has been planted on new land broken the previous summer, and worked down in the spring. The crops of '96, '97 and 1900 were raised on such land and gave large yields, while the cultivation of the crop left the soil in excellent condition for grain. The corn binder which is in universal use in other sections, can seldom be afforded on new and stumpy farms. Cutting by hand is facilitated by the planting in rows. The shock should not be large, though late in the fall, if the labor can be afforded, the small shocks may with profit be thrown together into larger ones for protection. In this section it is not possible to stack cornfodder, as it will always spoil in the stack. It should be fed from the shock. Cutting pays with coarse stalks, but where power and a cutter are not available it is a simple matter to grow them fine by close planting. The feeding value of cornfodder is equal to that of timothy hay, with the advantage of being succulent. It will not take the place of clover or of bran for milk cows, nor will timothy. But it will winter stock over in very fair condition.

Sorghum or sugarcane is occasionally tried in place of cornfodder. The experiment farm has demonstrated that this is a great mistake. Sorghum will never give the yield in this section that cornfodder will. In 1900, a season particularly favorable to sorghum by reason of dry, hot weather in the spring and summer, the yield was 3.8 tons as against 5.1 to 6.4 tons for cornfodder. In 1902, a cold, moderately wet year, sorghum gave practically no crop—cutting 1.25 tons, partly weeds, against 5 tons for corn. Sorghum is a plant for dry, hot climates, and the seed is much slower than corn to germinate, which cuts down the growing season and increases the danger of weeds choking out the crop. It should never be substituted for corn. The same is true of such crops as Kaffir and Jerusalem corn or Dhoura maize, Teosinte and others, all southern forage plants, the results from which on the experiment farm have been even less encouraging than with sorghum.

Millet is a heavy feeder and does best on bottom land. It is apt to be light on sandy soil. It is a useful crop when there is not enough meadow seeded down to produce hay

sufficient for the stock; though if cornfodder be used, there is not much necessity for millet. It is usually sown as a catch crop. In '99, after potatoes planted that spring had been drowned out, and failed to come up, millet was sown July 1st and produced over a ton per acre. Again in 1900, a field of 4 acres sown the preceding spring to grass, was burned out on a south exposure by the drought. This field was plowed and sown to millet on June 27th, and gave 1.25 tons per acre. German millet is about two weeks later in ripening than the common millet, and requires nearly the full season to ripen. It makes a difference, therefore, which variety is sown if late seeding is necessary. The late crop of 1900 was common millet, and was well matured for hay. That of '99 was German millet, and when cut, but few heads had appeared. The yield was about the same in either case but the more mature fodder was of a better quality for feeding. On the farm, the millet plots have been sown about June 1st. From that date till the 10th is the best period to sow the crop. If sown earlier, the seed will take so long to sprout, and the small plants develope so slowly that the weeds will generally smother the crop if they are present. In '97 millet was sown May 17th, and the weeds choked out the millet. In any case, the ground should be freshly dragged before sowing. Once well started, millet easily overcomes weeds. While millet will produce a crop if sown late, by using early

TABLE CIV.—Yield of Millets Sown in 1902.

Plot	VARIETY	Date Sown	Height, Inches	Yield Per Acre
				tons
1	German	June 2	36	3.75
2	Japanese	"	40	5.30
3	Siberian	"	38	3.65
4	Hog	"	36	2.90
5	Early Fortune	"	25	2.93
6	Hungarian	"	34	3.20
7	Common	"	34	3.33
8	German	June 16	28	3.30
9	Common	"	33	3.08
10	German	June 30	21	2.55
11	Common	"	25	1.90

varieties, it will not usually do its best unless sown near June 1st. The best yields of millet were obtained in 1902 on bottom-land broken in '97, on which sod had been fall plowed in '01. Table CIV gives the yield in tons of seven varieties and the result of late sowing with two kinds. The yields must be discounted slightly for dampness when weighed. The plots were cut Sept. 16th. Siberian and Hungarian are of similar earliness with common millet and were fully headed. The season being cold and late, the German millet even in plot 7 was not headed out yet when cut. Early Fortune is a hog millet but has twice proven very poor, perhaps due to poor seed, and the plot was nearly all weeds. The Japanese millet is quite coarse and tall which accounts for the large yields but does not improve its feeding value. Plots 10 and 11, sown June 30th are seen to be much lighter in yield than those sown on the 1st or 15th. Plot 9, Common, was headed and fit to cut, and plot 11 had begun to head, though the stalks were dwarfed. But the German millet on plots 8 and 10 was quite immature. Millet must be cured in the fall, and the task is not easy. This fact must be considered before sowing too much of it.

Peas are a success only upon rather heavy soil. In '96, on light sandy soil 9 varieties gave yield of from 8 to 13.5 bushels per acre. In '98, these varieties, grown on bottom-land underlaid with clay, yielded from 15 to 28.8 bushels per acre. They are valuable for hog feed, and where soil is favorable, may be grown for such purpose. The harvesting is difficult. Peas should be sown as early as possible. They cannot be sown too early, and if late sown they suffer from mould.

Corn.—The experiment farm has each year tested a number of kinds of flint and dent corn, amounting in all to 25 varieties of flint, and 30 of dent. No attempt was made to keep these strains separate as it would have been impossible, and they must be grown side by side for proper comparison. The effort has been to determine the exact status of Grand Rapids as a corn producing locality by finding out what kinds would ripen there year after year. The data obtained applies to other localities directly, only when the conditions are nearly the same, but can be used as a basis of compari-

son for other points by allowing for differences in temperature and moisture. Seed corn, more than all other crops, is directly dependent on the total amount of heat and sunshine during the summer. The latitude north or south increases or decreases this total heat and directly modifies the kind of corn it is possible to grow. Corn needs a dry air and sunshine. The presence of much moisture due to swamps and woods or the nearness of large lakes like Superior, with fog, retards its growth. There is a theoreical standard of production for each locality, representing the largest and the best corn that can be depended on to ripen annually at that point. All smaller and earlier kinds than this will not produce as much, and larger and later kinds will not ripen. This standard shifts with the locality and makes it difficult to breed varieties of corn in one place which will be the best kinds for other and different localities. It accounts for the failure of corn, which does well at one point, to ripen at another. But districts as they become better developed, have uniformly improved the kinds of corn raised, as every one knows. This is due first to the reduction of the excessive moisture in the air and soil, by drainage and clearing, and secondly, to selection and improvement of the corn itself. These indisputable facts are often quoted to prove that northern Minnesota will in time grow as good corn as Iowa. This loses sight of the influences of latitude which will forever confine corn growing within certain limits, beyond which local modifications cannot pass. From the facts at hand, it is safe to prophesy that in the latitude of Grand Rapids dent corn of reasonable size may sometime be grown with perfect safety, but it will always be smaller and less productive than that grown from Princeton south. In testing varieties, the standard kinds have been obtained from seedsmen, and in addition, as many strains as possible from farmers at various points in the northeasern counties. Of the twenty-five flints tested, table CV gives the results obtained with eight standard kinds in an average of between four and seven years trial with each variety.

TABLE CV.—Average Results with 8 Varieties of Flint Corn at Grand Rapids, Minn.

Color	NAME	Height of Stalk	Length of Ear	No. of Rows of Kernels	Probability of Ripening at Grand Rapids
		ft.	Inches		
White and Bl'k Mix'd	Squaw	3½	7	8	Ripe
White	North Dakota White	4½	8	8	Ripe
Yellow	Gehn or North Dak. Yellow,	4½	8	8-12	Ripe
Yellow	Mercer	6	9	12	Glazed
Yellow	Smutnose	6	12	8-12	Glazed
Yellow	Triumph	6	10	12-14	Glazed
Red	King Philip	7	10	8	Dough
Yellow	Longfellow	7	10	8	Dough

The squaw corn will ripen anywhere in the state, and planted about two feet apart, is fairly productive. The ears spring from the stalk near the base, which is troublesome in cutting.

North Dakota white flint is squaw corn, selected and improved as the table shows, and is preferable to the former.

Gehn or North Dakota yellow corn is the earliest yellow flint of any size. This type forms the basis of many strains of early yellow flint that are being ripened at the Wadena, Crookston and other points. There are several names for this kind of flint, and considerable difference between the strains, but the short stalk seldom growing over 5 feet high, with ears seldom more than 8 inches long, may be safely taken as an index of its earliness in every case.

The Mercer, with a slightly improved modification, (the Triumph), represents the next type of flint. The stalk reaches six, sometimes seven feet in length and the ears are 9 to 12 inches long. To this class the Smutnose belongs. These flints are not safe in this latitude, seldom reaching more than glazing stage before frost. The red King Philip and the yellow Longfellow, 8 rowed flints, with stalks 7 feet high and ears 10 to 12 inches long, are still later types and do not get beyond the dough stage.

Dent is not considered as early or reliable as flint for pioneer localities. Table CVI gives 18 varieties, grown from two to seven years, selected as types from the 30 kinds tried. As with flint, the size and height of stalk are the best indication of earliness. The Palouse corn obtained from Washing-

ton, is very early but so small as to be worthless except as a curiosity. The Station has no seed. The mixed dent known as Bergs, comes the nearest to ripening of any kind tried so far.

The ordinary dents, advertised as early by seedmen, will not ripen here. Illustrations are, Northwestern, Queen, Pride of the North, Early Butler, and others. The necessity for adaptation of varieties to locality is well shown in the table by the Whitecap dent. Seed which was raised at Princeton gave a stalk 8 feet high and did not form fullsized kernels before frost. The same variety, which had been raised for a few years at Aitkin, grew 6 feet high and gave kernels which were well dented by fall. The Berg's dent is a mixed strain of this variety grown at Mentor in Polk Co., and this reaches a height of about five feet, and in that locality ripens every year. These are all Whitecap dent. Names are useless in determining the kind of corn to plant. One must for his

TABLE CVI.—Average Result with 18 Varieties of Dent Corn at Grand Rapids, Minn.

Color	NAME	Height of Stalk	Length of Ear	No. of Rows of Kernels	Probability of Ripening at Grand Rapids
		ft.	inches		
White	Palouse	2½	6	12-14	Ripe
Mixed	Berg's, (Polk County)	5	8	12-16	Ripe
Whitecap	Aitkin	6	8-9	12-16	Dented
White	St. Cloud	5	8	10-14	Dented
Yellow	Western King, (Aitkin)	6	8	12-16	Dented
Yellow	Early Michigan	7	8	16	Late Dough
Yellow	Early Yellow Canada	6½	9	16	Dough
Yellow Whitecap	Minnesota King	7	8	8-12	Dough
Yellow	Huron	7	8	12-18	Late Milk
Red Strp'd	Northwestern	7	8-9	10-16	Late Milk
Yellow	Dakota Queen	7½	8	12-20	Late Milk
Yellow	Dakota Yellow	7½	8	16	Milk
Yellow	Queen of the Prairie	8	8	16	Milk
Yellow	Early Butler	8	7-8	16	Milk
Yellow	Pride of the North	7½	8	12-16	Milk
White	Rustler	7	8	12-16	Milk
Whitecap	Princeton	8	8-10	12-16	Immature
Yellow	No. 13	8	8-10	12-16	Immature

own locality, either take corn that has been raised there already, or experiment till he finds something he can begin on. It will be said that better kinds of corn can be ripened in this locality than appear in the tables. This is true in some seasons. The average season, however, will not permit of the ripening of such kinds and in a cold year like 1902, even the Berg's dent did not mature except in very favorable locations. The influence of moisture was shown by this variety. At Mentor, a comparatively open and settled locality, it does uniformly well. When the seed is brought to Grand Rapids, which is further south, but moister on account of the presence of more woods and water, the corn falls off in height and quality and has to re-adapt itself to the locality. Taken to a point such as Cloquet, where the influence of the lake is felt, though still further south, this corn will not ripen at all. To ripen corn two things are necessary—sandy, warm, well matured soil, and early planting. The seed should be in the ground by May 20th, preferably by the 15th. It may be frozen off, but the chance must be taken. Sandy soil is necessary for its freedom from excessive moisture, and consequent warmth. Manuring and frequent cultivation, to give the best conditions for growth, should then insure a crop if the season and variety allow it.

Potatoes.—Are naturally adapted to new land, northern latitudes and a light sandy or sandy loam soil. They are an intensive crop requiring more labor and giving greater returns per acre than most field crops. For both these reasons, potatoes must take a conspicuous place in the agriculture of these northern counties. The extent to which they should be raised over and above the needs of the farm will depend the market both local and general. Duluth and the range towns must be supplied, and they ship most of their stock at present from Chisago county or further south. The quality of the potatoes raised in the northern counties is excellent and should insure a good market for shippers. But there is occasional damage chiefly from wet weather causing rot, which affects the keeping qualities. Blight and other fungous diseases are not prevalent. The foliage is usually healthy and vigorous.

The most important lesson to be learned by a new-comer, in potato culture, is to avoid planting potatoes on heavy soil or low lying fields. The northerly latitude, with less heat to evaporate the moisture and warm the soil, combined with the probability of heavy rainfall at some period during season, renders the risk of injury from drowning out so great as to be prohibitive. Should there be no other land availble, it will pay to ridge the land, and plant on the ridges, to allow the water to drain away. But when as is usual only a few acres are devoted to potatoes, the field selected should always be a well drained, sloping or elevated piece. The experience of the seven years planting on the farm illustrates this fact. The crop of '96 on light, drained soil, gave 203.5 bushels per acre for an average of two fields. In '97, a portion of the field was in a swale and the yield was cut down to 137.3 bushels per acre. In 1898 the crop was planted on a piece of new ground, broken the previous year, full of humus and of a loamy texture, underlaid with clay at 1 ft. to 2 ft. This was the best possible potato soil, with the exception, that it was not well drained, and water was apt to soak into it from higher ground. In order not to convey a false impression, it must be clearly stated that this piece was not swampy, had born heavy hardwood timber, consisting of oak, basswood and poplar and has since borne magnificent crops of grain and clover. The potatoes were injured on about one-half the piece, so that the yield on 8 acres averaged 132 bushels per acre while on the higher portions it gave just twice this, or 265 bushels per acre. The following season this whole field of 11.7 acres was again planted to potatoes, about May 24th. Heavy rains set in and not a sprout came up. Three weeks later, about 4 acres of the highest land was again planted to potatoes, which came up, but the rains continuing, the vines were drowned out and did not produce a crop.

As this season was wetter than usual, and in order to thoroughly test this question, 4.7 acres of this field were again planted to potatoes in 1900. This was the dry spring. The vines did splendidly until the later heavy rains set in, but the injurious effect of too much water at this late period (August) reduced the yield to 64 bushels per acre. The var-

ieties, planted on better drained soil, gave this year 209.6 bushels per acre. In 1901 the potatoes were planted on a sandy soil well drained with the exception of two corners, which were low. Upon these low spots, aggregating one-fifth of the field, the crop was completely ruined by rains, but the rest of the field averaged 158 bushels per acre.

The yield for 1902, when the crop was placed entirely upon well drained soil averaged for the fields, 202.9 bushels. This figure is as fair as any to represent the average possibility for potatoes, when mistakes are avoided. Under good management it may be higher, as is shown by the average yield of the potatoes grown in variety tests for six years. These plots naturally received the best location and treatment. They gave 242.7 bushels for all kinds, good and poor during that period. But the average of the fields, omitting the year of '99, was 149.6 per acre, the difference being due largely to drowning out.

The question of variety, with potatoes, is one of great importance, as there is a wide difference in yield. The difference averaged for 48 varieties, for two years, 214 bushels per acre, the highest yield being 246.3 bushels and the lowest, 132.3 bushels. Earliness, shape, color, size, keeping qualities and flavor give a wide range of choice, but between two varieties of equal merits in other respects, the question of yield is all important. It is not easy to test a large number of kinds for yield and be sure that the results really represent their relative producing power. The sensitiveness of potatoes to moisture in the soil causes a variation in yield every few feet, due to slight elevation or depression of the surface level, or change in the soil texture. There are other minor sources of variation not due to the potatoes, but the difference produced by moisture is far in excess of any other. The varieties to be tested should be grown in plots small enough to confine them all to a piece of ground which can be selected of fairly uniform character. If an equal number and weight of seed pieces be planted of each variety, an average of four or five years yields may be trusted to fairly indicate the best yielders, were it not for this variation due to soil moisture. There is a simple way of

equalizing this, though it has apparently not been tried so far to any extent by experiment stations. For the last two years, in our test with 52 varieties, a standard kind has been selected and planted every 7th row or 21 feet apart. The yields of these check plots were found to differ widely, but it was seen that where the check plots yielded best, the best yields of other varieties were obtained, and vice versa. The range in yield, even on the fairly uniform piece chosen in 1902, was from 282 bushels to 506 bushels for the standard variety. With such difference as this due to other causes than the quality of the varieties, no amount of averaging could be depended on to give truthful results. But with this

TABLE CX.—Yields of 48 Varieties of Potatoes, Average for Two Years.

KIND	Gross Yield	Per Cent Market-able	Net Yield	Earliness	Quality
Early Michigan	363.4	95.3	346.3	Early	Fair
Prizetaker	377.4	91.0	343.6	Med. to Late	Very Good
Northern Spy	852.0	93.9	330.5	Late	Good
Maggy Murphy	345.4	94.6	327.0	Late	Good
Wonderful	337.7	94.3	318.6	Late	Very Good
Rose No. 9	327.1	94.2	308.0	Late	Fair
State of Maine	332.4	92.5	307.7	Med. to Late	Good
Reeve's Rose	319.8	95.8	306.5	Late	Fair
Early Fordhook	335.7	91.0	305.4	Early	Good
Lincoln	324.6	93.4	303.3	Late	Good
Delaware	321.3	94.3	303.1	Med. to Late	Fair
Polaris	310.8	97.0	301.4	Med. to Late	Good
Carmen No. 3	310.2	96.6	299.5	Late	Good
Uncle Sam	305.5	96.3	294.3	Med. to Late	Good
Bartlett	326.1	89.6	292.3	Late	Very Good
American Wonder	309.6	93.3	289.0	Late	Very Good
Burbank	326 0	87.6	285 5	Late	Very Good
Early Sunlight	308.3	92.3	284.8	Medium	Good
Carmen No. 1	304.7	90.6	276.3	Medium	Very Good
Chase Seedling	301.3	90.8	273.6	Med. to Late	Good
Sislers	286.9	94.6	271.6	Late	Fair
Dakota Red	289.0	93.5	270 4	Med. to Late	Good
Early Triumph	310.4	86.6	268.9	Early	Good
Red American Wonder	274.7	97.2	267.0	Late	Very Good
White Ohio	284.9	92.9	264.9	Early	Good
Vanier	286.3	90.7	259.8	Late	Poor
Early Vaughan	287.3	90.4	259.7	Early	Very Good
Seedling No. 230	279.8	92.2	257.9	Med. to Late	Good
Pride of South Dakota	276.4	92.6	256.0	Med. to Late	Good
Seattle	278.7	91.8	255.9	Med. to Late	Fair
Red River Acme	282.4	89.3	253.4	Early	Fair
White Beauty	282.4	89.0	251.4	Med. to Late	Very Good
Rural New Yorker	266.0	97.7	250.9	Late	Good
Irish Cobbler	266.4	91.3	243.4	Medium	Good
Sir Walter Raleigh	246.2	94.2	232.0	Late	Fair
Main Crop	255.1	90.4	230.7	Medium	Good
Early Fortune	251.8	89.7	225.9	Medium	Fair
Livingston	242.5	91.2	221.3	Late	Fair
Seneca Beauty	225.8	94.5	213.4	Late	Very Good
Extra Early Pioneer	244.0	84.0	205.1	Early	Fair
Garfield	220.1	92.9	204.4	Med. to Late	Good
Early Andes	217.1	94.0	204.1	Early	Poor
Early Ohio	232.8	87.6	204.1	Early	Good
Herrington Peer	227.2	88.5	201.2	Med. to Late	Good
Early Norther	229.2	87.5	200.7	Medium	Good
Early Six Weeks	210.6	89.6	188.8	Early	Fair
Harvest Queen	156.2	89.4	139.7	Med. to Late	Good
Salzer's Million Dollar	151.5	87.3	132.3	Late	Fair

series of check plots, whose yields may be plotted on paper, and the "value" of each intermediate plot thus obtained by means of a curved line, it is easy to figure the yield of each variety in per cent of the check row. If the average yield of all the check plots is adapted as the standard yield, and the yield of each variety corrected by multiplying this figure by the percentage for the variety, the results must be as nearly accurate as can be obtained. The tests for the first five years were not conducted on this principle. During this time some 30 kinds were tried. In 1901, many new varieties were obtained and the best of old kinds saved. The comparison both of these and the new kinds is thought to be so much more accurate for the two years, that figures for previous yields are omitted. Table CX gives the average yield for two years of 48 varieties, showing the total yield and the yield of marketable tubers, on which the rank is based. The main crop potatoes have been planted between the 23rd of May and 1st of June depending on the season. They are dug between Sept. 25th and Oct. 10th. The very late kinds do not ripen before frost, and where other things are equal preference should be given to the second early or medium late varieties.

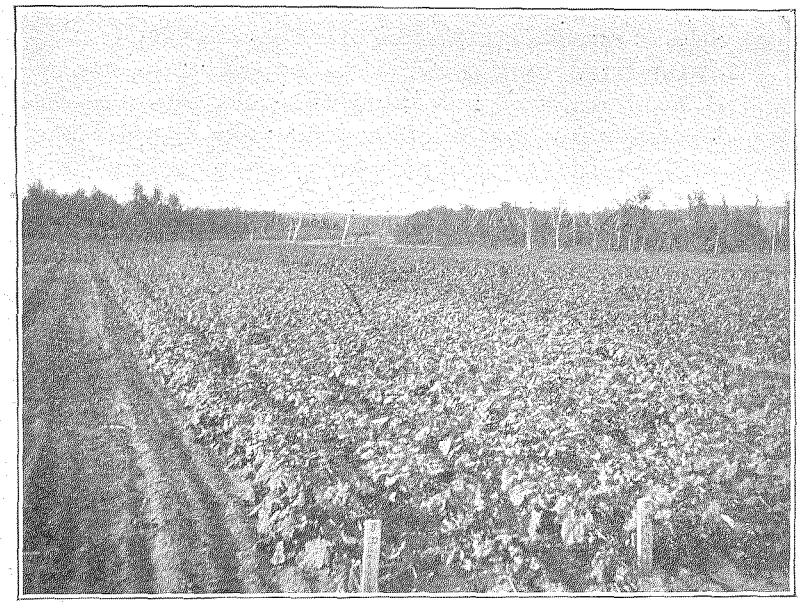
Where there is so much new land to be brought under cultivation, potatoes will usually be planted on such soil, and with good results. There is a certain amount of work to be done in breaking and harrowing, and the planting and cultivation of potatoes helps to work down the surface. On such land there will be very little if any scab, even from scabby seed. But no crop, not even potatoes, will give best yields the first year, nor until the soil is well rotted and worked up. This was well illustrated in 1902. A field which had had the timber cut from it in '98, and had since been closely pastured by sheep, was broken late in the fall of 1901. In the spring it was cross plowed and planted to potatoes, yielding 175 bushels per acre. A strip along one end of this field had been plowed early in the spring of 1901, sown to oats and pastured off by sheep during the summer. This was plowed with the rest in spring of 1902, and the yield on the piece was at the rate of 342 bushels per acre or nearly twice as much. A part of this difference may be

charged to more favorable slope and situation, but it was chiefly due to the more thorough preparation of the soil by summer fallowing and pasturing. This piece was quite sandy.

It is a great temptation to plant potatoes year after year, on a well prepared piece, especially in a garden, or when the farm is not being cleared up rapidly. But this is usually rendered impossible by the appearance of scab. Scab is never present in new soil, and is brought into it by the potatoes planted there. It is a microscopic plant, which feeds upon the potato. Its spores or seeds fill the soil, and when succeeding crops are planted, there is so much scab in the soil that the crop is completely covered and largely ruined. In new land the only scab present is what is on the seed pieces, which is not enough to affect the crop. The second crop on the same soil may show considerable scab, but not usually enough to spoil its sale. But let potatoes be planted a third year on this land, now thoroughly infected, and the crop will be almost worthless. If for any reason it is intended to use certain land for potatoes continuously, scab may be entirely kept out if done from the start. The seed potatoes should be soaked every spring before planting, unless they are absolutely clean, in a solution of corrosive sublimate, 2 oz. to 8 gallons water, for an hour. This destroys the scab on the potato and there will be none on the crop as none exists in the soil. This method is ineffective, on soil already filled with scab, for one cannot soak the ground with sublimate. The possiblity of keeping out scab has been demonstrated on a plot, where potatoes so treated have been planted for three consecutive seasons without a trace of the disease appearing in the crop. But scab will sometimes appear in spite of these precautions. In this case it always comes from the manure of animals which have eaten scabby potatoes, or from parings or slops containing scab. A new piece, in potatoes the first time, for which the seed had been treated, was so infected in 1902 by hogs, so that considerable scab appeared in the crop. These facts are given that the nature of scab may be thoroughly understood and not as an inducement to grow potatoes continuously on the same soil. The scab itself is a protest against

such farming and even if kept out, blight and bugs get worse, and the yield falls off through the soil getting out of condition and losing its humus and fertility. On the same plot treated three years for scab successfully, the yield in 1901 was 131 bushels compared with an average of 244 bushels on four other plots which for the two years previous had been planted to grain and grass. When ground becomes scabby it remains so for several years even if no potatoes are planted in the interval. Where potatoes cannot be planted on new land they can always be put upon a piece which has not grown them for some time. Sod land is excellent if rightly treated. Old sod should be rather deeply plowed in the fall and worked up for the potatoes. Sod which bore clover the preceding year and had both crops cut, is not of sufficient toughness to interfere with the growth of the potatoes and may be spring plowed, planting them in every third furrow next the edge. This was done in 1902, and gave 230 bushels per acre. The richness of the land greatly affects the size of the yield. In '96, on two fields which had received the same treatment previously, the one dressed with stable manure gave 231 bushels while the other field yielded 183 bushels per acre. The difference in yield before noted, on the plot continuously in potatoes, with other plots on which the crops were rotated, is due largely to the better condition of the soil of these plots due to adding sod or manure. Stable manure has a more beneficial effect, and lasts longer in the soil than the prepared commercial fertilizers. A comparative test with potatoes on two plots that had grown oats for two years previous, using about the same amount of fertilizer according to the analysis as was contained in the manure used, gave a yield of 282.5 bushels for the manured plot, and 180 bushels on the plot with fertilizer. In raising potatoes, big yields pay, and with no crop will it pay better to expend thought, labor and manure, in the proper selection and preparation of the soil.

Roots may be made quite an important crop for stock feeding in this section. Their place as a feed is more as a supplement to the main ration than a substitute. Fed in small quantities with hay or fodder, the roots keep the system in good condition, improve the digestion, and cause the



Root Varieties.—Lower Northeast Field.

animal to turn its other feed to better account. They may be substituted for other feeds if necessary, in which case much larger quantities must be fed, as there is about 90 per cent water in roots as against 13 per cent in hay.

The root crops on the farm have not been uniformly successful, as they have twice suffered from water on fields otherwise well suited to roots but too low to be safe through a wet spell. It has been shown too, that sandy land cropped for some time without sod, will not raise a large crop of roots. But root crops may be grown under wetter soil conditions than potatoes.

Rutabagas have uniformly given the largest yields and are adapted to the widest range of soil conditions. They are often sown and produce well on breaking and new land is especially favorable for their development. Mangels require not only better soil for large yields, but it must be in better tilth. The results obtained will for these reasons, not average as well as for rutabagas. Sugar beets never yield

as well as mangels in this section. Carrots do well but do not yield as heavy a crop as the other roots.

In 1900, the roots were raised on soil that was well suited to all kinds of roots, and the yields obtained were representative not only of the normal yield of roots under favorable conditions, but of the relative productiveness of the different kinds. They are given in table CXI. These relative yields are about as fair as general comparison as it is thought possible to get, eliminating the influence of soils and other conditions.

TABLE CXI.—Yield of Varieties of Roots in 1900.

Kind	VARIETY	Yield, Tons per acre	Average for Class
Rutabaga	Prizewinner	26.1	
	Sweet German	23.7	
	Monarch Swede	23.5	
	Carters Swede	22.8	24.0 Tons
Mangel	Red Globe	19.9	
	Golden Giant	19.7	
	Mammoth Long Red	18.3	
	Tabers Gate Post	17.0	
	Champion Yellow Post	16.4	
	Golden Tankard	13.4	17.6 Tons
Sugar Beet	Klein Wanzlebener	14.7	
	Vilmorin	11.9	13.3 Tons
Carrot	Victoria, White	8.5	
	White Belgium	7.6	
	Mastodon, White	7.0	
	Yellow Belgium	5.6	7.2 Tons

In 1901 the crop was grown on poor droughty soil, made so by lack of humus from cropping continuously to cultivated crops. Under these conditions rutabagas gave 10.1 tons per acre, and carrots 11 tons, while mangels yielded 6.2 tons per acre.

The season of 1902 was too cold and backward for largest yields of roots. The average, in fair soil, was, rutabagas 17.2 tons, mangels 7.5 tons, sugar beets 6.4 tons and carrots 9.2 tons per acre.

For two years the roots have been sown at two different dates to test the effect on the yield. In 1901, rutabagas sown May 15th yielded less than those sown June 1st, but in 1902 the early sown was the heaviest crop, due to the slow season. The late crop yielded 14.7 tons, and the early

sown gave 19.7 tons or 34 per cent more. The yield of late sown rutabagas in 1901 gave 26 per cent more than the early sown, and this result will probably be obtained in an ordinary season. The mangels have always given larger yields when sown early—the difference averaging 1.7 tons in favor of the early sown. With carrots and sugar beets the results have also favored early sowing.

Rotations.—The necessity for growing the principal crops of this section, as grain, grass, potatoes and cornfodder, in rotation, in order to maintain the yield of the crop and the fertility of the soil, has been pointed out for each crop. It is perhaps the most important question connected with our farming, at least the one in which mistakes are most apt to be made. The amount of land devoted to grain, grass and potatoes or corn respectively, will vary with the amount of stock kept, nearness to market and other factors. But the farmer generally knows about how much of his land he would like to have in each kind of crop. We have seen how largely the yield of grass may be increased by plowing up the meadow at the end of two or three years and seeding down a new piece, and how oats or cornfodder or potatoes give bigger crops on sod than on land under continuous cultivation. A proper rotation which will benefit the soil, depends almost absolutely on the plowing under of sod, and unless one is willing to plan his farm management with this end in view, he can do very little of real value, by rotating his other crops. A perfect rotation cannot be devised for a new farm which is being cleared up but the principle can be applied on any farm and the details altered every year if necessary, to meet the conditions. A perfect rotation is a system by which the farm is divided into a definite number of fields of nearly equal size, and a rotation of crops grown, so that there are as many different crops as the farm has fields. Each crop is grown on a different field each year, in a regular order, so that the acreage of each crop each year is the same. An example of a four year rotation, would be corn or potatoes, then oats seeded down, and meadow two years, the fifth year bringing it back to the starting point with corn again. Should this rotation be perfected for a farm, there would be four fields, two of

which would be in meadow, one in oats, and one in corn each year. The following year the corn or potatoes would be upon the fall plowed meadow which had lain two years, the oats on the corn ground of the previous year, and the oat field which was seeded down would be in meadow. And so on until the fifth year would see the crops on the same fields as at first. This general principle can be modified in countless ways to meet different conditions. One way is to have two sets of fields on which rotations of different lengths are practiced.

To illustrate this principle of perfect rotations, a set of eight plots was laid out in 1900 on good soil, and two rotations were started, a three year and a five year. In this case it took but one year to bring the proper crop upon the proper fields so that in the second year of the rotation, each crop was where it belonged. The five year rotation was cornfodder, for which the land was manured, then wheat seeded down, meadow two years, then oats followed the sixth year by cornfodder, thus beginning the rotation again. The three year course was oats seeded down, clover with the second crop plowed under, and potatoes the third year on

TABLE CXII.—Showing the order of Cropping Eight Plots brought under a Five Course and Three Course Rotation.

1	6	7	8
1900—Wheat.	1900—(Cornfodder.)	1900—Potatoes.	1900—(Oats.)
1901—Clover, Two Crops.	1901 (Manure Cornfodder.)	1901—Oats.	1901—Potatoes.
1902—Timothy.	1902—Potatoes.	1902—Clover.	1902—Oats.
1903—Oats.	1903—Oats.	1903—Potatoes.	1903—Clover.
1904—Manure Cornfodder.	1904—Clover.	1904—Oats.	1904—Potatoes.
1905—Wheat.	1905—Potatoes.	1905—Clover.	1905—Oats.

2	3	4	5
1900—(Wheat.)	1900—(Wheat.)	1900—Oats.	1900—Manure Cornfodder.
1901—Clover.	1901—Oats.	1901—Manure Cornfodder.	1901—Wheat.
1902—Oats.	1902—Manure Cornfodder.	1902—Wheat.	1902—Clover, Two Crops.
1903—Manure Cornfodder	1903—Wheat.	1903—Clover, Two Crops.	1903—Timothy.
1904—Wheat.	1904—Clover, Two Crops.	1904—Timothy.	1904—Oats.
1905—Clover, Two Crops.	1905—Timothy.	1905—Oats.	1905—Manure Cornfodder.

the sod. In table CXII is shown the crops as they are being grown upon these eight fields, and the crops which were grown in 1900 and 1901 to bring the fields into proper rotation. The crops not in the rotation, but necessary at first to prepare for the proper crop, are in brackets. The field in 1899 was clover meadow and the crops of 1900 were planted on a fall plowed second crop of clover. Were a farm of 80 acres put into this rotation, 30 acres would each year be in meadow, of which 20 acres would be in clover, and 10 acres timothy. There would be 20 acres of second crop clover, half of which would be plowed under, and the other half cut or pastured. Thirty acres would be in grain, 20 of oats, 10 of wheat. Ten acres would raise cornfodder, and this amount would be manured each year, and 10 acres would be for potatoes. Had the crops actually harvested on the tenth acre plots in the experiment in 1902, been gathered on such a farm it would have yielded in 1902, 867 bushels of oats, 303 bushels of wheat, 39.2 tons cornfodder, 55.8 tons of first crop and 5 tons second crop clover, with 10 acres plowed under, 17.3 tons timothy, and 2925 bushels potatoes. At 30 cents, the oats would be worth $260.10, the wheat at 60 cents, $181.80. Clover at $8.00 per ton, $486.40; cornfodder at $4.00, $156.80; timothy at $10.00, $173.00, and potatoes at 25 cents $731.25, or a total of $1,989.35. Neither the yields quoted, nor the prices, are excessive for ideal conditions. But the average yield for any farm of 80 acres would necessarily fall below the yields obtained on these small tenth acre plots.

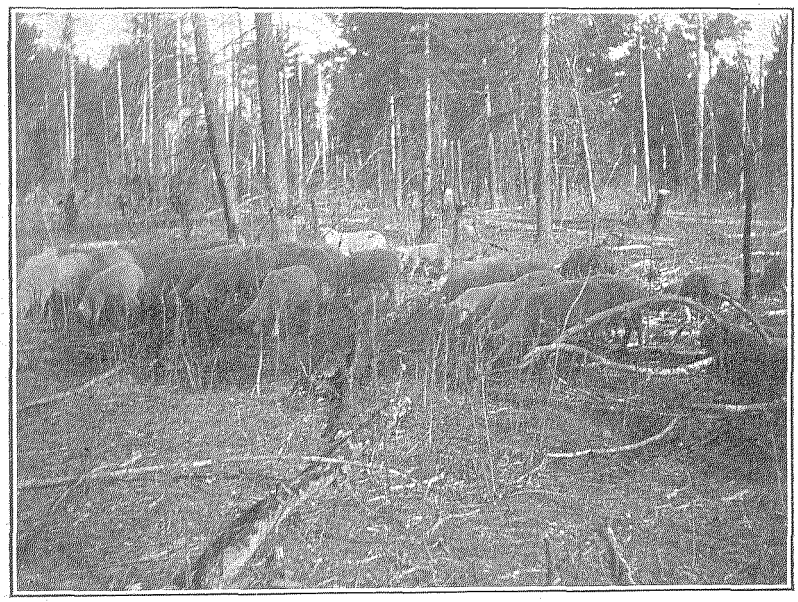
This does not diminish the force of the illustration, for on as much of the land as is of equal value, crops as good can be grown, if the sod is plowed and the crops rotated under a similar system. Not even on the experiment farm is it possible to bring the fields into a fixed rotation like the above, and neither is it necessary. But the general plan can be adhered to, and the details modified to meet the circumstances. A single, general rotation may be best. Such a one, of four years, is practiced on the farm. Grain crops are all classed alike and make up one year. Meadow is given two years and cultivated crops including corn, cornfodder, potatoes and roots makes the fourth. The fields, which are

much cut up by roads, ditches, and plots, are classed into four groups of approximately equal productive area. As new land is cleared, it is classed in with one or the other of these groups as circumstances dictate. The rigid four year sequence is seldom followed on any of these fields, but the crops are always planned to bring the field back into its place in the rotation if they depart from it. If the clover catch should fail, a second grain crop would be raised, and the fields seeded down again, but allowed to remain only one year, instead of two in meadow. Should it be desirable to plow under the second crop of clover, the field would either be brought into meadow again a year sooner and allowed to lie three years or an extra grain or cultivated crop would be raised on it. Millet has sometimes been raised in place of potatoes, and other changes made. The possibility of such modifications makes the system elastic enough to meet any condition that may arise, and at the same time the general plan can be closely followed, guess work done away with and the numerous beneficial results of rotation be permanently secured. The main point is to have a general plan to suit the conditions of the farm, and then work steadily towards it. Examples have been given of three, four and five years rotations, and of two rotations on the same farm. These are only a few of the many plans that may be adapted, but the simpler they are the better. The four year rotation of cultivated crops, grains and meadow two years, lends itself to more changes and conditions than any other, which is why it was adapted, or rather forced itself upon the experiment farm. The proportion of the various crops raised under this rotation seems to more nearly and easily approximate the general needs of the farmers here than other rotations. In fact, it serves as the type of rotation in this section and all other successful rotations are mere modifications of this one. To test the effect of different methods of rotation in a thorough manner both on the composition of the soil and the yields produced, twenty-four plots were laid in 1900, on each of which a different rotation was started. Sixteen of these include grass in a three four or five year course. The others are planned without grass depending on manure, or the plowing under of rye for fertilization. Some

are purposely wrong in principle as when oats or potatoes are raised year after on the same soil. This experiment can be run as long as the farm lasts. The results of the different methods pursued will become more and more evident each year, until they finally stand as unmistakeable object lessons in proper methods of rotation.

Clearing Land.—There is no area of any extent in the northeastern counties of Minnesota, but what is or was timbered or swampy. All land except natural meadows must be cleared before it can be farmed.

Fire has done an enormous amount of work in clearing land. In many sections, destructive fires have so reduced the expense of clearing that they have given an impetus to



Sheep clearing land of small brush.—Sheep Pasture.

settlement. But it may be doubted whether this benefit is not more than offset by the injury done to the soil by burning and destroying the humus and litter on its surface. The injury is greatest on sandy soil, as it has most need of the humus. Severely burned sandy land, while easiest of any to

clear, should be regarded with suspicion as its fertility may have been greatly impaired by the fires. On heavier soils the injury is not so pronounced and here the fire may have been of great help in reducing the amount of work necessary in clearing.

In clearing standing hardwood timber or small pine, as jack pine, the trees may be made to aid by their weight, in pulling the stump by cutting the roots and pulling the tree over. This needs a double block and chain or rope, with a chunk or log laid next to the stump to lift the roots clear in the fall. This chain is attached for the pull as high up the tree as possible. More often the timber, especially pine, has been or will be cut, and the stumps left. The ground between them is cleared and broken and either cropped or seeded down until the stumps are removed. In brushing and subduing the land, sheep are an aid in keeping down sprouts about certain classes of hardwood stumps, but chiefly in destroying small brush and in their effect on the soil. They will not pull down or kill brush that stands five feet high or over. This will have to be cut. But the roots in the soil rot, and its wildness is mellowed by the tramping, grazing and manure of the sheep. Soil that has been closely pastured for 3 years, by sheep, on the farm was easily broken by a common cross plow, and raised 200 bushels of potatoes in 1902, when broken late the preceding fall. Thus it is seen that sheep can do only a limited amount of work in clearing, but as they are getting a living at the same time, their services are so much clear gain to the work. The stumps rot more quickly when pastured about than if grown up in brush. The cost of brushing, picking up and burning exclusive of stumping or removing standing timber will vary from $2.00 to $8.00 per acre. For gathering fine brush and rubbish an iron rake may be used whose teeth are bent back at the tips to run easily over the surface. A blacksmith can make one, mounting the teeth in a wooden back for lightness.

Stumping is the chief expense of clearing. With hard wood and small sappy Norway or Jack pine, the stumps rot in three or four years, and when pulled then do not bring up much dirt, come easier and yet are solid enough not to break off. If left much longer many of them will break, leaving

Partially cleared land in sheep pasture.

the root in the ground, while if pulled green the fibrous roots bring up a mass of earth difficult to loosen. This indicates that the cheapest method is to pasture the land for three or four years after the timber is cut before pulling the stumps. Pine stumps containing heartwood do not decay appreciably though the small roots rot off. They are apparently just as sound after twenty years as when cut.

In pulling stumps much can be done with blocks and chain or cable, in lieu of a stump puller. If the larger stumps are split with dynamite and the roots cut, a good team with two blocks will pull out nearly everything. In no case does it pay to pull very large pine stumps whole. After they are pulled they are very hard to handle. By splitting them with dynamite the pieces may be pulled separately. This allows the use of a small stump puller which can be dragged about and set up quickly and easily. Dynamite does very efficient work on stumps in thus splitting them and in blowing most of the dirt off the roots so that they will burn more easily. It is inserted under the stump in a hole made in the dirt with

a crowbar, or preferably a dirt augur. The amount depends upon the size and kind of stump, but four sticks will split up a very large pine stump, and one stick or one-half pound will take out a good sized poplar. Too much as well as too little can be used, and for economic work the dynamite should never be entirely depended on but used in connection with the stump puller or block and line. If a good, small or medium stump puller can be afforded it is probably the cheapest method and requires less labor than the block and line. The method employed must be determined by means, circumstances and judgment. The cost of pulling, piling and burning the stumps will vary between wide limits, depending on the thickness of the timber, the soil, age of stumps, kind and size, but in no case will it be low where the land was heavily timbered. A hard wood piece, mostly poplar, very thick, with about ten small standing pines per acre, was stumped with block and line, piled and burned, for $19.00 per acre, which did not include the removal of the brush and logs. Six acres heavy tamarac cost for stumping by hand and with block $18.60 per acre. Heavy pine cannot be stumped for much less than $25.00 to $30.00 per acre, using dynamite and stump pullers, while some lands covered sparsely with second growth hardwood, as poplar, may be stumped for from $6.00 to $10.00 per acre.

Breaking is best done in June or early July. The roots of the brush and wild plants at this period have very little food stored up and die, while in the fall they are well stocked with food and will sprout and grow in the spring if there is a chance. It will not often pay to backset as with prairie sod, as the furrow is necessarily uneven from roots and inequalities in the surface and will be turned rather deep. It may be worked down on the surface in the following spring, and planted to potatoes, cornfodder or oats. With early plowing, especially on soil that has been mellowed by pasturing with sheep cross-plowing or back-setting may be feasible in the fall or spring thus getting the soil worked up sooner.

Swamp Land.—A large amount of land in the northern counties is swampy. These swamps fall into two classes—those which grow timber and those on which neither timber or grass grows, except stunted spruce.

The timbered swamps grow either cedar, tamarac or black ash. The timber shows the presence of a mineral soil, and the possibility of making these swamps into hay or farm lands by clearing and drainage. Hay bottoms, or beaver meadows show the same conditions by a luxuriant growth of grass. The remaining type of swamp, which is not found along water ways but back from the streams is what is known as muskeg. It may always be recognized by the absence of large trees or tall grass. It grows small black spruce, which may be one hundred years old, and less than an inch thick. The surface of the muskeg is a mat of sphagnum moss interlaced with the roots of two dwarf shrubs which bear small entire shiny leaves. Often fly catcher plants are found and a few species of grass resembling wire grass. These swamps are sometimes found filling small depressions, at other times stretching over miles of territory. The soil is an accumulation of the decayed remains of the moss chiefly and has little if any mineral matter in it. When perfectly dry it will burn up, but it seldom gets dry as the level surface is always more or less saturated and flooded with water. The moss has the power of retaining a great deal of water and stays damp while there is any water within its reach.

It is often stated that these muskegs will make the finest hay meadows in time similar to those in the more southern districts of the state. This is a dangerous generality especially if it leads to placing any monetary value on such lands. It may be doubted whether these swamps in the southern portion were formed from the accumulation of decayed moss. But granted that they were once similar, there is now a wide difference. The first problem is how to get the muskeg into condition for grass. If there is an outlet and a fall it can be drained. Ditches are easily dug in the peat at a cost of about one half of what the same would cost in soil, but to drain a piece of bog it is not enough to provide an outlet ditch. The ditches must surround the piece to prevent water flowing into it as it permeates so slowly that no amount of ditching will otherwise keep it dry in a wet season. Then comes the removal of the moss, for while it remains nothing else can grow. Burning would appear to be the cheapest

way but experience shows that unless so dry that it is apt to burn holes, the damp moss will not burn off evenly and not at all in a wet season. If it is kept up for several years, burning may finally get rid of the moss on drained portions. To remove the moss mechanically as was done on a portion of the swamp on the experiment farm requires an outlay of about $75.00 per acre. Granted that these swamps will grow grass, it is a question whether it will pay to try to subdue them for that purpose. But if in addition the ultimate result is doubtful, it becomes an economic mistake to expend any energy on their reclamation, which might be put upon clearing land of which there is no doubt. These facts are not given at random. The experiment farm has worked for seven years upon a small muskeg, ten acres in extent. A portion of the swamp has been drained since '96 and another piece since '98. On both pieces the moss was stripped off after failing to get rid of it by burning. A horse and three pronged hook was used to tear up the tough bunches of moss and shrubs and haul it off. The ground was broken and left to rot. But after three and five years respectively the swamp has not been gotten into tame meadow. It would be unsuitable for any other crop but hay in any case on account of its coldness and loose texture. The conclusion founded on these facts is that it will not pay farmers to buy or try to subdue these muskegs, and loose general statements drawn from experience in other sections will not be accepted as proof to the contrary.

To more thoroughly investigate the character of these soils, ten carefully selected samples were sent to the chemist of the Experiment Station at St. Anthony Park, his official report is herewith submitted.

REPORT ON COMPOSITION OF MUSKEG SOILS.

Ten samples of muskeg soil were submitted to complete chemical analysis. The samples were taken in the fall of 1902 by Superintendent Chapman by whom the following description of the samples is given:

Sample No. 1.—From a large muskeg; a strip was drained in '97 and cleared of moss and shrubs in 1900, and the sample taken just below the surface.

Sample No. 2 is taken from the same locality as No. 1, but was taken at a depth of 2 ft. 6 in. below the surface.

Sample No. 3 is from a large muskeg, natural state, taken just below the surface. This sample represents a raw undrained muskeg which has never been brought under cultivation.

Sample No. 4 is from the same locality as sample No. 3 but was taken at a depth of 3 ft. from the surface.

Sample No. 5 is from the large muskeg west of No. 1, where it was drained but not cleared. The sample was taken just below the surface.

Sample No. 6 is a muskeg soil cleared of moss in 1899, drained and plowed. The sample was taken just below the surface.

Sample No. 7 is from a small muskeg, drained, cleared and partly grown over with grass; the sample was taken from a place where blue joint grew vigorously.

Sample No. 8, muskeg from the same locality as No. 7, taken at a depth of 10 inches.

Sample No. 9, muskeg from the same locality as No. 7, taken at a depth of 20 inches.

Sample No. 10, muskeg from the same locality as No. 7, taken at a depth of 30 inches.

From the description of the samples, it will be observed that there are represented muskeg soils in the natural state, No. 3; drained, No. 5; drained and cleared, No. 1; drained, cleared and plowed, No. 6; and producing blue joint grass, No. 7.

Difficulty was experienced in the sampling and preparation of the soils for analytical operations because of the large amount of fibrous vegetable matter which they contained. Only a very small amount of fine earth was obtained. Analysis of the fine earth and of the fibrous material showed that there was practically no difference in the amount of volatile, principally vegetable, matter in each. The coarse fibrous material had practically the same composition as that which passed through a one-half mm. seive.

All of the samples gave a decided acid reaction. Attempts were made to determine the total and relative amounts of acid in the various samples. All of the known

methods for the determination of acidity of soils were tried, but satisfactory results were not obtained with any of the methods, direct titration with standard alkali solution gave the most satisfactory results. It was found that a gram of dry soil contained organic acids equivalent to from .02 to .03 grams of hydrochloric acid. There is nearly 2 per cent of acid in terms of hydrochloric acid in these soils. The difference in the amount of acid in the various samples was small, the soils which had been drained and plowed showing a tendency to contain slightly less acid than the raw undrained muskegs. Cultivation appears to have lessened the acidity. This is due undoubtedly to the decay of vegetable matter and organic acids.

The amount of volatile matter in all of the soils is exceedingly high, ranging from 85 to 95 per cent, the largest amount being present in the raw muskeg sample at a depth of 3 feet where but little decay had taken place. The amount of mineral matter in the samples ranged from about 5 to 15 per cent, and is no more than is ordinarily found in agricultural crops. Straw will frequently yield more ash or mineral matter than is found in some of these samples. The sample which produced the blue joint hay contained 85 per cent of volatile or vegetable matter while the raw muskeg contained from 90 to 95. Draining, stripping of moss, plowing and other treatment which the muskeg received has reduced the vegetable matter in sample No. 7 to 85 per cent. From the analysis of these samples, it would appear that a portion of the vegetable matter must first undergo decay before a natural grass crop can be produced and such a crop can not be produced when more than 85 per cent of vegetable matter is present.

The amount of nitrogen in all of the soils was high, ten times more than is found in soils from the same locality but of different origin. In bringing the muskeg into condition so as to produce blue joint, the amount of nitrogen is apparently reduced. Since nitrogen is one of the elements which forms a part of the vegetable matter of soils, a loss of vegetable matter would necessarily be followed by a corresponding loss of nitrogen.

The amount of humus materials in the soil ranges from

22 to 48 per cent. Since humus represents the vegetable substances more thoroughly decayed, it is readily understood why more humus is found in samples 6, 7 and 8 than in 1, 3 and 4. The vegetable matter in the thoroughly drained and cultivated soils is more completely decayed.

The amount of mineral matter in all of the soils with the exception of 9 and 10 is small. When the soils were burned, a fine grey ash-like residue was obtained. This mineral matter contained quite a large amount of sulphur due undoubtedly to the sulphur being in chemical combination and forming a part of the organic matter. The nitrogen and sulphur content of the soil would indicate that a large portion of the nitrogen was in forms allied to complex proteids. The amounts of iron and aluminia in these soils are small. The vegetable matter contained an appreciable but variable amount of phosphoric acid and also a fair amount of both potash and lime.

These soils are, as indicated by the analyses, entirely different in chemical composition from ordinary arable soils. The principal change which they undergo while being brought under cultivation is decay of the vegetable matter followed by a corresponding decrease in acidity. As to whether these soils are suitable for grass lands must be decided largely by local conditions, considering principally drainage and expense involved in bringing the soils into condition to produce hay. Soils as No. 7, contain a large amount of nitrogen and a fair amount of potash and lime. When brought under cultivation such soils are generally found to be the most suitable for the production of hay. Applications of wood ashes, lime or marl would undoubtedly prove beneficial on these soils in neutralizing the organic (vegetable) acids, and supplying active alkaline matters which appear to be deficient.

Soil No.	Description of Samples	Volatile Matter: (mainly vegetable)	Nitrogen.	Humus (partially decayed vegetable matter.)	Insoluble matter, (mainly sand and insoluble silicates.)	Iron and Aluminia.	Lime (Ca O)	Magnesia (Mg O)	Sulphates (S O_3)	Phosphoric Acid ($P_2 O_5$)	Potash ($K_2 O$)
1	Large muskeg-drained, stripped cleared of moss and stumps..	92.25	2.91	26.65	6.00	.76	.41	.12	.11	.22	.15
2	Same as No. 1, 2 feet 6 in. deep.	93.78	2.36	27.35	5.69	.31	.22	.08	.07	.02	.19
3	Large muskeg, natural state.....	94.04	2.45	23.42	4.11	.79	.47	.17	.12	.19	.32
4	Same as No. 3, 3-feet deep.....	95.13	1.50	22.78	3.23	.34	.25	.13	.08	.09	.26
5	Large muskeg, drained but not cleared.....	91.69	2.49	25.13	5.84	.96	.40	.19	.20	.24	.41
6	Portion south of ditch, cleared of moss 1899, plowed and drained.....	90.14	2.43	30.40	8.40	.70	.29	.08	.10	.13	.27
7	Small muskeg, cleared and grown up in grass sampled where blue joint grew vigorously.....	85.31	1.98	31.42	12.81	.99	.18	.06	.17	.03	.32
8	Same as No. 7 10-in. deep.....	86.40	2.76	48.01	12.45	.61	.29	.10	.20	.03	.23
9	Same as No. 8, 20-in. deep.....	46.16	1.36	27.29	52.55	.84	.26	.04	.07	.05	.27
10	Same as No 9, 30-in. deep.....	8.59	.19	4.39	88.71	.15	.37	.04	.01	.01	.28

HARRY SNYDER.

It is to be noted that on the spot where sample No. 7 was taken, blue joint grass grew vigorously. This had been drained since '96 and cleared of moss since 1899, and 1902 was the first year that the grass grew on the spot. Special attention is called to the fact that at this place the mineral subsoil was only about 2 feet below the surface and blended with the muskeg fenn below.

Sample 2, taken at 2½ feet, shows no mineral soil, and while this spot has been drained and cleaned an equal length of time, it is non-productive. It may therefore be inferred that where the peat is less than a foot in thickness it will be more easily subjugated than where it is from two to three feet deep. The depth can easily be ascertained with a post augur.

Weeds.—A new farm theoretically should have no weeds. But they cannot be kept out very long. There is very little grass seed that does not contain some few weed seeds. Oats

sometimes sold for seed oats may contain weed seeds. Hay and feed contain them. In this way most species of weeds are quickly brought into a new region. While good cultivation will keep most kinds in check, it is not well to depend on this in the case of mustard. If this weed once gets into the soil it will require years of care and work to eradicate it. The seed will lie in the ground when plowed under until it is turned up again near enough to the surface to sprout. Great care should be taken not to sow mustard with grain, and should it appear it must be pulled out at once. In this way the farm may be kept clean of it from the start. For lack of these precautions many new farms in this region are already as badly infested as farms in other sections.

Sheep.—No class of live stock has such an important relation to the development of a new farm as sheep. This is due to their habit of browsing on brush.

The experiment farm has maintained a flock of about seventy five sheep for five years, and used them in clearing up new land. The experience gained has been very useful. It is often claimed that sheep will live entirely upon brush. It is true that they can do so, but they will not do their best under such conditions. This fact should be emphasized. Should it be necessary to confine sheep entirely to brush, they will be apt to get poor, and the lambs will not make the best growth, as an all brush pasture seems to shorten the milk supply of the ewes. This has been amply demonstrated for two different summers with the flock on the farm. The sheep will destroy the brush quicker when confined upon it. It therefore becomes a question of which is the more important end to be attained. Should it be impossible to furnish the sheep with any pasture except brush, one must not expect the sheep to get fat upon it, for they will seldom do so unless there is a large amount of grass or peavines in the pasture. It is possible however to make extensive use of the sheep to pasture off brush and at the same time bring them through the season in good form. This can be done when the farm is sufficiently well developed to devote some of the cleared land to sheep pasture. The sheep may then be kept on the brush in the spring into July, at which period the foliage is fresh, and browsing does the most effective

Land, Sheep Pasture well browsed.

work. After the middle of July the brush is dry and unpalatable, browsing does not kill it as well, and the sheep will rapidly run down. It is then that they should be turned upon other pasture. In the early spring a little grass or rye pasture will also be of great help. Such a rotation of pasture requires fencing, and this will often deter the farmer from adapting it. But it should be held as a goal to work for, if sheep are to be a permanent addition to the farm.

Success with sheep depends upon the lambs. The old sheep may thrive, apparently, but if the lambs are weak and die the flock soon melts away. The strength of the lambs depends more than all else, on the care and management of the flock through the winter. A common mistake, and one always attended with fatal consequences to the lambs, is to keep the sheep too warm. No amount of cold will hurt a sheep with its thick coat of wool, but crowding into a close shed overheats and sweats them, so that they take cold when turned out. Sheep should be protected in the winter

not from cold, but from snow and wind, especially drafts. The doors of the sheep shed should be large and on the south side. They should always be open, even in the coldest weather. The best door is one of two sections, the lower of which can be closed to keep the sheep in when necessary, while the upper is left open. The sheep should be out doors all the time at will except in storms, and at least one feed a day should be given them at some distance from their shed, to make them take exercise in going and coming. During the winter of '98 and '99 the sheep, which had been bought quite late in the fall were wintered over in a shed too small for them, without proper doors. The effect of the crowding and overheating became evident in the spring, when out of fifty lambs, only six were strong enough to live, in spite of the utmost care during lambing. Since that time, with the same ewes and a proper shed and handling, the lambs have been strong and healthy. Sheep can be wintered over on wild hay and cornfodder, but here again, best results cannot be expected. Clover hay is nearly a perfect feed. But where oats or bran can be fed towards spring it will improve the tone of the flock at lambing time. The sheep should not be bred before December 1st, unless one wishes early March lambs and has the additional experience and equipment necessary for success. May is the most favorable month for lambing. While during the summer sheep require the least attention of any class of stock, they make up for it in lambing season. At this time the flock should be under constant watch. If the weather is cold or wet, young lambs unless found at once will never get up, but die of chill and exposure. If the lamb is weak when found, it may often be gotten on its feet by holding the ewe and allowing it to suck, or even feeding it from a bottle. Promptness in rendering this aid to the lamb is the important point. Delay so draws on the vitality of the lamb that it can not often be saved. No amount of care will avail a constitutionally weak lamb unless it is raised on a bottle as a pet, which method has its limitations. But strong vigorous lambs if born under unfavorable circumstances will need these attentions, and here is where the care pays. A strong lamb born in the sunshine seldom needs attention. The ewe and young lamb should be at

once separated from the flock and placed by themselves in a small pen for a day or two. Young ewes will otherwise often desert their lambs, and it is seldom that a ewe can be made to adopt another's lamb unless it is done at once after the loss of the lamb at birth. They should be kept in a yard or grass plot for at least a week, until the lamb is strong enough to run with the flock. While sheep will live on the water they get in the dew on the grass and succulence of the herbage, and by eating snow, pure water, both in summer and winter is essential to their thrift. They should be free to choose their own time of pasturing. In the summer this will be at early dawn, and at dusk. It will not pay beginners to start with full blooded ewes, as much must be learned the first year or two and the experience might be costly. On the other hand, Merinos, though they pick a better living from the brush, are too small and take too long to improve for best results from the standpoint of mutton or quantity of wool. Grades of the large breeds should be secured if possible and bred to a full blooded buck. The flock on the farm was originally grade Merinos and though bred to an Oxford every year for three seasons, the type does not yet show the improvement that could have been obtained in the first cross with grades of a larger and better class. It is a mistake to use a grade buck if a full blooded can be obtained, as the improvement will be less pronounced or altogether wanting, the animal usually lacking prepotency, or the power of getting off-spring similar to himself. Wolves have never bothered the flock. They may easily become a serious menace and necessitate careful corralling at night, in sections where they are abundant. Bells placed on the ewes are a protection.

Summer Pasture Crops for Sheep.—Of the crops raised as a supplementary pasture for sheep, cornfodder has proved most useful. For this purpose it is sown thick, in drills, and is pastured when it stands about 3 feet high. It furnishes pasture in August, on which the sheep thrive. Sown June 1st, it reaches the desired height during the latter part of July. For late pasture it can be sown at any time up to July 10th. To illustrate the amount of pasture afforded by corn, a field of 3.6 acres in 1900 pastured 73 sheep for 31 days,

during August and early September. In 1902, cornfodder was sown in the furrow on breaking and furnished a large amount of pasture for the flock in August.

Rape is often mentioned as a supplementary sheep pasture. It has not done well on light or sandy soils on the farm. It requires a rich, heavy or black soil for good results and should be sown by July 15th at the latest. It resists frost and thus furnishes pasture after corn is frozen, and sheep relish it above all other crops. Early spring pasture is best furnished by winter rye, which may be pastured by May 10th. It is of great benefit in lambing season. Grain may be devoted to pasture and will furnish a large amount of feed as it can be eaten down two or three times if taken before the shoots appear. It is not often that grain will be devoted to this use. Second crop clover makes excellent late fall pasture after frost, and spring seeding if heavy and not pastured till very late, may be used in some instances. Grass makes good pasture for sheep at any season.

The farm, more for experiment work than as an example, has fenced a twenty acre field into five small fields each 9x70 rods. The sheep have access to each field from a lane running along one end of the piece. A five year rotation of corn, oats, clover, timothy, winter rye and rape or other forage crop, is grown on these fields. The sheep run upon brush, but whenever it is deemed best they are turned on one of these crops, according to the season. Ten rods of moveable fencing confines them to the portion of the field they can use, and the rest is harvested in due season.

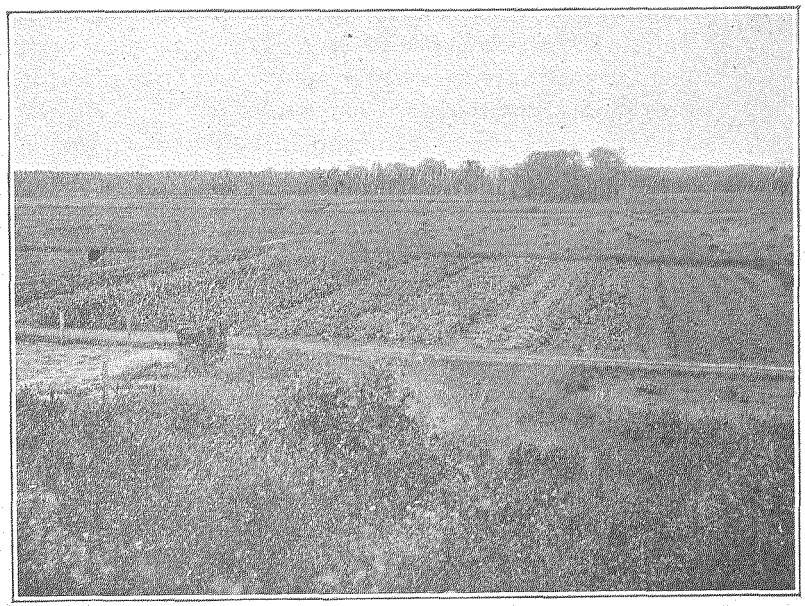
Cattle.—The station has maintained a dairy herd but has lacked the means for experiments with feeds and milk production on an accurate, scientific basis.

The period of winter feeding is somewhat longer than in the southern portions of the state. Ordinary pasture is not worth much before the last week in May. In many localities the wild pasture is very abundant, and cattle do well on it. The production of feed for wintering the stock will determine the number that can be kept. Where wild hay is available it is an important element in solving the problem at the outset. As the farm is cleared, more tame forage can be raised, especially cornfodder and clover. Whether dairy cows are to

be kept, or a type more suited to beef production, must be determined by the market. All dairy products command a good price which helps to offset the cost of feed. Where hay can be marketed at from $10.00 to $12.00 per ton there is often more money in it than to feed it to stock, The settler can best determine for himself how much and what class of cattle it will pay him to raise.

Hogs.—Swine raising on a large scale is not apt to prove profitable, except where some local condition provides a source of feed, as in the vicinity of large towns. It will always pay to have pigs to eat the slops and waste from the house. Lumber camps raise good pork by letting the pigs run wild in the summer and feeding in the winter from the camp. Barley makes the best feed to raise for pigs, as corn is uncertain. Probably the best plan is to raise spring litters, provide range for them during the summer and finish off as soon as possible in the fall and early winter, carrying over only the brood sows.

Garden Vegetables.—Garden vegetables prefer a light sandy soil well manured. The excellent growth of vegetables



Garden and Field looking east from Barn.

is often taken as an index of the agricultural possibilities of a region. Vegetables depend for their quality not necessarily on the strength of the soil but on its quickness, warmth, and fertilization with manure. The production of grain, grass and other staple crops is a better standard of general merit than the size of a cabbage. The vegetable garden should always be manured no matter what soil it is on, as the results will be increased in proportion. Nearly every kind of vegetable has annually been raised at the farm and of very good quality and size. The season is short for watermelons and muskmelons and only the earliest varieties should be tried. Two varieties of watermelons which have ripened are Hungarian Honey and Fordhook. Tomatoes should also be started as early as possible in the spring, in the house in order to ripen a crop before frost. They should be set out about June 5th. Sweet corn will always mature for the table, even the later varieties.

Strawberries.—The strawberry crop in this country ripens from July 4th to 20th. This brings it on the market after the berries from other sections are exhausted and insures a good sale. Strawberry culture on the farm has been successful. Strawberries need fertility and the plants will soon deteriorate on poor soil not well enriched with manure. They also need, and must have plenty of moisture during the ripening of the crop. A rather low but drained spot should be chosen. The land should be plowed in the fall, rather deeply. Manure can be plowed in at that time, but it is better to spread it, if fine, on the plowed surface and work it in with a disc harrow if possible. It is better still to make both applications.

In this section as well as elsewhere the plants should be set in the spring, not the fall, and allowed one season to grow before bearing a crop. If set one and one half feet apart in rows four to four and one half feet apart and cultivated one way, they are the least trouble. The runners are not clipped but form a matted row. A covering of 2 to 3 inches of straw is spread late in the fall after the ground is frozen and is left on the plants in the spring as long as possible to delay them till danger of frost is past. This straw must then be raked off the plants but left between the rows,

to keep down the weeds and retain the moisture in the soil for the crop. The bed should seldom be left to bear more than two years as it is so much easier to set out a new bed and plans should be made to do so each year. Strawberries differ in their adaptability to our conditions and some varieties do not do well. Of many kinds tested, the Brandwine, Clyde, Splendid, Lovett and Bederwood, have given best results. All are staminate or perfect varieties and may be planted alone. Haverland and Warfield are good but need one of the above kinds in alternate rows with them for pollenation.

Raspberries.—It is not safe to grow any kinds of raspberries here without winter protection, but if this is given, most of the better varieties may be successfully raised. This simply means keeping them trimmed out in hills by cutting off all but a few suckers each summer, then bending the bunch of vines over and throwing dirt on the tops and the stalks as far as possible. Straw may be thrown on but if snow is plentiful, it is not necessary. The kinds successfully raised on the farm are Turner, Marlboro and Loudon. Others have not been tried. Blackberries, treated similarly, will ripen a crop. In 1902 the Snyder, and Ancient Britain varieties yielded well. Currants need a rich preferably clay soil and will not thrive on sand. The climate is favorable.

Apples.—In planting trees it must be bone in mind that the northern counties of Minnesota are beyond the natural range of the apple. Success can only be won by careful choice of varieties and local conditions. A northeast slope, not too steep, is universally recommended for apples, as it gives protection in the summer from hot winds. But in this section the slope is not so important as the soil. Poor success will follow setting out trees on sandy soil with gravelly subsoil. The apple needs a clay subsoil at not too great a depth. To secure this, it would be better to take level land or a south slope if the soil on a north slope is not right. The presence of large bodies of water improves the local chances of success with apples, by holding off the first frost in the fall and delaying the spring thaws which cause sunscald. But unless the hardiest varieties are planted, failure is certain. It is a dangerous plan to buy trees of nurseries

located many hundreds of miles away, which have been necessarily grown under the different conditions, and in most cases, will be of varieties that will not live in this climate. Local nurserymen, who have been struggling with this problem of hardiness for years, are more apt to offer only the best varieties. The tests on the experiment farm have not been made under the best soil conditions, and growth has not been vigorous.

Some idea is being obtained of the relative hardiness of the varieties. Of the apples, Hibernal, Pattens Greening and Duchess in favored localities, are recommended for trial. Of crabs, Martha is perfectly hardy. Virginia and Transcendent should be tried. If other kinds are planted, they should be only those advertised as extra hardy. In this section apples should always be set out in the spring.

Plums.—The varieties of American or native plums are nearly all perfectly hardy here and will grow upon sandy soil as well as clay. They will succeed therefore in many places where apples will fail. To obtain a crop several kinds must be set out near each other. Some plums ripen too late, and the varieties marked early should be chosen for planting. The orchard on the farm, set out in 1899, bore in 1902 a very good crop of plums. The best plum tested was the Cheney both in earliness and size. It will ripen in any season. The Aitkin is not a vigorous tree nor a good bearer, but as it blossoms at the same time as the Cheney it is recommended for planting with it for the pollenation of the flowers. New Ulm and Wolff, both do well on poor soil and ripen in an ordinary season. Weaver ripens but was small. It will probably do well on good soil. DeSoto, Rollingstone and Surprise are too late in ripening to be safe here. It is recommended that a wide use be made of these plums, as the chances of failure are very small.

Reforestation.—In order to investigate the cost and practibility of re-stocking the land with pine, which is too hilly, rocky or sandy for agriculture, a number of acres were laid off on the west half of the northeast quarter section and planted in 1900 to white and Norway pine. The trees used had been furnished by the Bureau of Forestry in '98 and had grown two years in nursery rows. When transplanted they were a foot to eighteen inches high. This was too large. They should have been moved a year earlier. The growth was retarded a year by the transplanting and the cost was probably 30 to 40 per cent greater than for trees a year younger. The cost of digging, transporting one-half mile in wagons, and planting, was a little less than one-half cent for each tree. The trees were set at equal distances each way. The cost per acre depended on the distance apart they were

set. At four feet, 2722 trees were required, and the cost was $11.20. At six feet intervals, it took 1210 trees, costing $5.60. Eight feet apart required 681 trees, and cost $3.14, while at 10 feet, 435 trees were used, at a cost of about $2.50. The greater interval adding somewhat to the proportional cost of planting. To transplant evergreens it is absolutely necessary to keep the roots from a moments exposure to the sun. In this case they were dug but the roots kept covered with dirt till moved. They were then put upright in a wagon box and drenched. From this they were taken in baskets and handed one at a time to the planters, who set them out at once. No water is required, and it is even injurious to water evergreens after they are set out. The ground should be moist when planted. These trees were set by cutting the surface on three sides and turning it back, taking out a spadeful of dirt, inserting the plant, tramping the loose spadeful on the roots and turning back the sod next the stem, stamping into place. In spite of the prolonged drought of 1900, nearly 95 per cent of the trees have lived and are now making rapid growth. A fire lane has been cleared and plowed on the west side. In all 12½ acres were planted, each acre representing a type of planting. Four acres are pure white pine at 4, 6, 8 and 10 feet intervals. Each is duplicated with Norway pine. One acre bears mixed white and Norway pine, and on one, jack pine was planted alternately with white and Norway. Norway and Scotch pine occupy an acre, in mixture, to test the relative merits of the two species. It is hoped that the experience and information thus gained may serve as a guide for similar work wherever conducted.

Ornamental Shrubs.—Of the many kinds of shrubs planted on the farm, some have proved perfectly hardy and of value for ornamental planting. They are as follows:

Lilac.—Tartarian Honeysuckle, a bush resembling lilac in habit, bearing small pink flowers in the spring.

Caragana, or Russian pea tree, a bush with pinnate leaves, bearing small yellow flowers.

Buckthorn, a small thorny shrub.

Buffalo Berry, a shrub, bearing grayish green leaves and tart red berries resembling currants. These are borne profusely and make excellent jelly.

These shrubs all make good hedge plants, and all but buckthorn are equally ornamental set out as individuals. Of native shrubs, the highbush cranberry and dwarf maple are useful and the kinnikinnick or red dogwood. Spireas, hydrangias and Russian olive have not always escaped injury in winter. The roots of clematis come through in good condition.