The University of Minnesota

AGRICULTURAL EXPERIMENT STATION

THIRTY-SECOND ANNUAL REPORT

PART III

Popular Discussions of Some of the Experimental Work in Agronomy, Soils, Horticulture, and Forestry

1924

UNIVERSITY FARM, ST. PAUL
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THIRTY-SECOND ANNUAL REPORT OF THE AGRICULTURAL EXPERIMENT STATION, 1923-24

PART III

AGRONOMY

WHY AND HOW BETTER VARIETIES OF GRAIN ARE MADE

The fact is being emphasized more and more that at the present rate of increase in the population the producers of small grains are going to be called on eventually to supply greater quantities of their products. This will be necessary if the present standards of living are maintained. One way in which an increased production may be effected is for the farmer to grow improved varieties of cereals, the use of which insures the farmer an increase in the amount of his salable goods and allows him to produce his crop at a lower cost per bushel. While the argument may be raised that an increased production of a particular crop may result in a lower price on the market, the fact still remains that the farmer who produces the most bushels per unit of land and labor is the one who makes the most money. He is thereby enabled to procure the greatest number of comforts for himself and his family. The staff of the plant breeding section, together with other members of the Agricultural Experiment Station, is expending considerable energy in an effort to develop better varieties of small grain crops and to make them available to farmers. Each new variety is the result of definite effort to meet some particular need.

VARIETIES MADE BY SELECTION

Gopher, A Stiff-Strawed Oat

Recently a new variety of oats, Gopher, has been placed on the list of recommended varieties for Minnesota. Gopher, Minn. No. 674, is a white-seeded, early-maturing oat having stiff straw and open panicles. It is a sixty-day variety and this, with its ability to stand up, is making Gopher particularly popular with the farmers of Minnesota.

About eight years ago several hundred single plants were selected from the 60-day variety being grown in the plant breeding nursery. The seed from each of these plants was grown the following year in a short row. Some were discarded the first year because they were found to be of little value but many were carried for several years in comparison with the standard varieties. One selection in particular, which had very stiff straw in comparative tests with other varieties, has proved an especially good yielder. This selection was named Gopher.

For three years, 1920 to 1922 inclusive. Gopher was grown at several places over the state. Averaging the results at University Farm and the branch stations, Gopher was the highest yielding early variety by 12 per cent. At Morris, Gopher yielded 6 per cent more than any other variety, either early or late, and at Waseca 20 per cent. In other tests in Southern Minnesota during this period, Gopher yielded from 5 to 20 per cent higher than any other variety. From these data it can be seen that Gopher is the best yielding early oats for any section of Minnesota and for Southern Minnesota it outyields all other varieties.

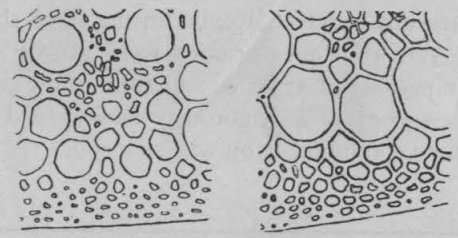
Oats Plant Rows

Each two short rows is the progeny of a single plant selected the preceding year. This photograph shows the large number of individuals studied in order to produce a new variety. From this large number, perhaps only one will finally be increased for distribution as a new variety.

It matters little how well a variety promises to yield unless all the product can be harvested.

If at harvest time the grain lodges so that from 20 to 75 per cent of the crop is left in the field, the farmer would be better off had he grown a variety which yielded slightly less but which stood up so that all could be gathered. The particularly desirable feature of Gopher is that it not only yields unusually well but it stands up remarkably well so that all the crop can be harvested.

Frequently an understanding of why a thing is true is of considerable interest and often of real value. A study was made of Gopher oats to discover, if possible, what it was that enabled it to remain erect when other varieties lodged. The stems were studied in comparison with stems of other varieties. Cross-sections of the stems were made and it was learned that certain cells (called sclerenchyma cells) had unusually thick walls. The extra thickness of these cell walls is the factor making for stiffness of straw in Gopher oats.



Cross-Section of Stems of Oats. At left, Gopher; at right, a lodging strain

Note the larger holes in the figure on the right. The areas around the holes are the cell walls. The thick cell walls of Gopher contribute to its stiffness of straw.

Wilt-Resistant Varieties of Flax

Two other selections appearing on the recommended list are Winona and Chippewa flax. A few years ago Bolley, of the North Dakota Agricultural Experiment Station, found that if ordinary flax was grown on soil infested with the wilt organism (wilt-sick soil), some plants grew normally and appeared not at all injured by the disease. Some were attacked but recovered under favorable conditions, while many seedlings were killed before they were able to get through the ground. Bolley saved seed from the healthy plants and in a few years had produced a strain of flax which remained healthy and vigorous when grown on the most wilt-sick soil. Similar experiments were conducted at the Minnesota station.[1] Many lines were produced, each of which was started from a single plant. These were grown continuously on soil known to be heavily infested with the wilt organism. In fact, these flax selections were grown year after year on the same field and while many of the ordinary types were entirely destroyed, the new selections grew vigorously and yielded well. Two of the best selections were

[1] The breeding of disease resisting varieties of various farm crops is a joint project between the sections of plant breeding and of plant pathology.

increased and have been named Winona and Chippewa. These wilt-resistant varieties have been yielding from 8 to 38 per cent more than the variety from which they were selected. A selection which has been named Redwing is showing considerable promise. It has yielded 5 per cent more than any other variety at University Farm over a three-year period, and at Crookston 7 per cent more than any other variety over a four-year period.

It was thought at first that if a wilt-resistant flax were grown for several years on soil free from the wilt organism that resistance would be lost. Very carefully conducted experiments have shown that such is not the case. Wilt-resistant varieties were grown away from the wilt-sick plots for periods of from one to four years and when grown again on wilt-sick soil grew as vigorously and yielded as well as the same varieties grown continuously on wilt-sick soil.

The resistance to wilt does not, however, take care of the evils incident to poor cultural methods.

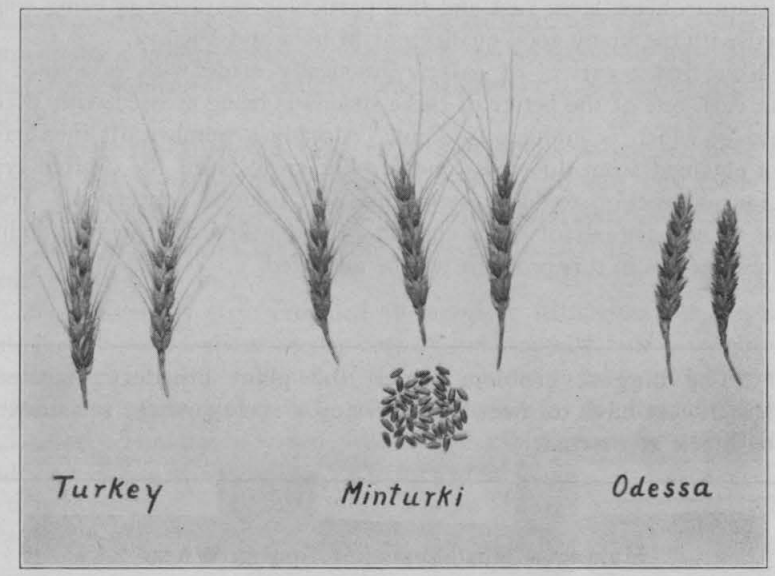
If flax is sown late, when conditions are unfavorable for flax and favorable for the wilt organism, even the most resistant variety may be seriously damaged. On the other hand, when correct farming practices are followed, Chippewa or Winona can be grown with the assurance of a very fine yield regardless of the wilt organism in the soil.

VARIETIES MADE BY HYBRIDIZATION

Minturki Winter Wheat

How often have we listened to a wonderful singer and wished that we could add his accomplishment to the ones we already possess, or to a splendid address and coveted the ability to hold in the same manner the attention of an audience. How glad we would be if we could combine these accomplishments with the ones we now possess. This, of course, is an impossibility with ourselves but to some extent it is exactly what the plant breeders are doing with crop varieties—combining in one variety the desirable characters of several. Turkey winter wheat is a good milling wheat for a winter variety but under Minnesota conditions is seriously injured in some seasons by winter-killing. Odessa is very winter-hardy but is a low yielder. Minturki, Minn. No. 1507, is a new variety produced at the Minnesota station by crossing Odessa with Turkey. It is a Turkey type and excels in winter-hardiness. It

also has considerable resistance to black stem rust. In the Minturki variety, then, are combined the several good "accomplishments" of the two varieties, Turkey and Odessa, used as parents in the cross.



Heads of Minturki, the Best Winter Wheat for Minnesota, and Its Two Parents
Minturki combines the winter-hardiness of Odessa with the good qualities of Turkey.

Minturki wheat outyielded all other winter wheats at Morris and Waseca from 1921 to 1924 inclusive. At Waseca and Morris, Minturki outyielded Marquis 35 per cent and 15 per cent, respectively, during this period. Farmers over the southern part of the state have obtained consistently good crops of Minturki wheat. The value of this variety was particularly apparent in the years in which rust was a serious factor and the spring-sown wheat was hardly worth cutting. The unusual winter-hardiness of Minturki and its resistance to black stem rust account very largely for these favorable reports. This new winter wheat is a good example of what can be done in the way of producing better varieties by the process of hybridization.

Smooth-Awned Barley and Rust-Resistant Oats

Some of the other projects under way are the production of a smooth-awned, six-rowed barley, and a rust-resistant, open-panicled variety of oats. The problem first mentioned is far enough along that a name has been given to the prospective new variety. It combines resistance to spot blotch and the smooth-awned character in a six-rowed, high-yielding variety. Because of the smoothness of its awns the variety has been named Velvet.

Many lines of oats are being tested, all of which are open-panicled and resistant to black stem rust. They are the results of crosses of White Russian with Minota and Victory. White Russian is highly resistant to black stem rust and this particular character is being combined with the many good qualities of Minota and Victory.

Now that a variety of oats is practically made with resistance to stem rust, one of the better of these strains is being crossed with Black Mesdag, which is immune to smut. Already a number of lines have been obtained from this cross and are known to be of the desired type so far as reaction to black stem rust and smut is concerned. They need to be purified for other characters and tested for yielding ability before success in this problem will be admitted.

The biggest problem which the plant breeders of the Northwest have to meet is to develop a spring wheat resistant to black stem rust.

Making a Rust-Resistant Spring Wheat

Several varieties of wheat have some resistance to stem rust. A hybrid of Iumillo crossed with Marquis is worthy of special mention. The Iumillo parent is a durum wheat with very high resistance, while Marquis has the other desirable characters. One particular strain, Iumillo × Marquis II-15-44, is nearly as resistant as the Iumillo parent. Its milling quality is not entirely satisfactory and it has been recrossed with standard bread wheats in order to combine all desired qualities in one variety.

As one problem is solved, new ones become known. Several years ago a smooth-awned barley variety of the Manchuria type was practically ready for introduction when a serious epidemic of spot blotch severely damaged what were thought to be the better strains. This disease had not been prevalent before, but the problem was begun anew to take into consideration this phase of it. Velvet barley is the result. As a variety with commendable characteristics is produced, it is introduced as the best that is available and the breeders begin immediately to produce something better. At the present time breeding problems are largely concerned with combining disease resistance with other desirable characters. That various plant diseases exact an enormous yearly toll from the farmers is commonly known. If varieties can be secured which are not affected by these diseases many millions of dollars will be saved for the growers.

KING CORN IN MINNESOTA

The story was once told of an adventurous, youthful king of crop plants who came across the mountains to the Great Miami Valley in Ohio and settled there; but he soon learned that there was a brighter future and a larger domain to the west, so he came on into Illinois, where he established his kingdom and reigned, a true king of a golden harvest.

Whether the king still rules from his Illinois palace we have not learned, but his kingdom has surely widened to the westward and northward; and it is now believed that King Corn comes to Minnesota each summer to spend his vacation, and incidentally to look after his kingdom here.

In acreage this great crop led all others in Minnesota for the first time in 1923 when about 26 per cent of the cropping land was in corn. Its popularity will be retained or strengthened only so long as the crop continues to be a comparatively sure investment for the farmers' capital and labor. This again will depend considerably upon the adaptability and the yielding ability of the varieties available.

Problem of Adapted Varieties

The fundamental problem for the corn farmer in Minnesota is that of securing for each community the variety or varieties which will yield the greatest number of bushels per acre, and yet mature corn before frost.

This problem is not so difficult as it might seem. As corn is a highly cross-pollinated crop, all commercial varieties are mixtures of types. A variety may be relatively pure for seed color and other ear characteristics for which it may have been selected, but there must be great variability for many other characters—height of stalk, habit of stooling, or growth habit. Yield seems to be correlated to a considerable extent with variability, and whenever in a commercial variety there is inbreeding or too much tendency toward uniformity there seems to be a corresponding lowering of the ability to yield.

Selection in Corn

As all commercial varieties of corn are variable, it is possible to select for certain ear or plant characteristics and mold a variety in almost any direction. Witness the great variety of strains of Minnesota No. 13, as well as of almost any old established variety.

The real question confronting the farmer is: How shall I select my seed corn and how can I thereby maintain or increase the yielding ability? Much has been said as to the relation of various seed and ear characteristics to yield. Considerable emphasis has been placed on complicated systems of selection and ear-to-row methods of breeding. Such methods are indeed valuable in adapting a variety to new conditions, but what of them as a means of improvement of standard adapted varieties?

Experiments were conducted at University Farm to determine the comparative value of various methods of selection in Rustler White dent. These methods varied from the simplest procedure of selection of good ears at husking time, as from a wagon box, to the most complex system of selecting high-yielding ears by the ear-to-row plan and crossing these to produce foundation stock for a seed plot. The experiment was continued for four years. The results indicate that there is little, if any, value in the use of any ear-to-row method of selection in an adapted variety. Furthermore, when the ears were scored and selected closely to score-card type there was a rather significant decrease in yield over other methods of selection.

Suggestions for the Farmer Who Produces His Own Seed

1. Home grown seed is desirable. Grow a variety of corn that is well adapted to your locality.

2. Ears for seed should be selected from perfect-stand hills and from vigorous, healthy stalks. Plants that are green when the ear approaches maturity insure normal maturity of the ear.

3. Close selection for ear type leads to a reduction in yielding ability. For this reason no close selection to ear type should be made.

4. Proper storing of seed ears is fully as important as methods of seed selection.

First-Generation Crosses

From the results of several years' test of first-generation crosses between different varieties of corn, there appears to be only one type which gives promise for Minnesota. A first-generation cross between an early flint and a later dent yields about as well as the dent variety and matures nearly as early as the early flint. Farmers in Northern Minnesota might find such a cross valuable. Crossed seed can be obtained by planting the varieties in alternate rows and detasseling all of one variety before the silks of that variety appear, the seed ears being harvested only from the detasseled row. To cross an early with a late variety it is necessary to plant the late variety several days before the early one so that both mature about the same time. If crosses are used, the crossed seed must be produced each year to obtain desirable results.

Present Outlook for Corn Improvement

It seems evident from the experiments cited, as well as from similar results at other experiment stations, that in an adapted variety of corn there can be little hope of material improvement by the use of any of the systems of breeding which depend upon mass selection. Selection keeps the variety up to a certain standard.

Cross-pollination is the rule in corn. Each seed results from the union of two sex cells—one in the pollen grain and the other in the unfertilized seed borne on the cob. It is thus evident that pollen grains from a number of plants may have fertilized seeds on a single ear of corn. Consequently, any method of selection based upon ear or plant type takes into consideration only the female parent, and while such a procedure may be better than no selection, it must be recognized as a very inefficient process.

What a foolish thing it would be to attempt to breed a pedigreed strain of livestock by spending all the energy in selecting the females and paying no attention whatever to the sires used. The same principle applies equally well to corn.

How To Control the Male Parentage

The only possible way to control the male or pollen parentage in corn is actually to control pollination. This may be done by tying a bag over the tassel and one over the ear before the silk appears. After the silk has come out well the tassel bag is shaken to collect the pollen in it, and the pollen is then transferred to the silk of the ear on the same plant. This constitutes self-pollination, or the very closest form of inbreeding. Inbred lines obtained as a result of such breeding indicate very clearly the great amount of variation which existed in the original variety. Some lines appear vigorous, others become weak very rapidly. Some will stand up well, while others lodge badly. Resistance to corn smut will be noted in some. A great variety of abnormalities will appear, as white or "albino" seedlings, spotted and striped plants, plants with crooked stalks, dwarfs, and pale green types, many of which die. These and many other abnormalities have been carried along in the normal variety as weaknesses. They can not be gotten rid of by mass selection; it is a very simple matter, however, to discard those characters when they appear in inbred strains.

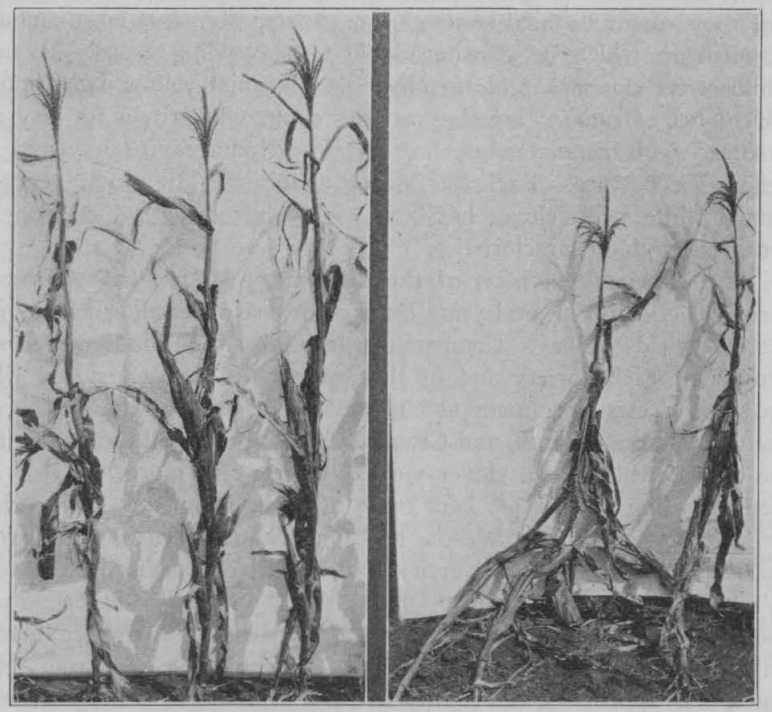
It Is Possible to Control the Male Parentage by Hand Pollination
Bags are placed on both the tassel and the ear shoot before the silks appear. When the silks are well out, pollen from the tassel bag is dusted on the silks. The ear bag is replaced and left on till harvest.

Production of a New Variety from Inbred Strains

After a few years of continuous inbreeding most of the strains will be weakened somewhat in vigor. There are great differences, however, between the inbred strains in this respect. The best and most vigorous inbred strains may then be recombined by crossing and a new variety produced. In this process of recombination two strains may be used in a single cross, four strains may be united by a so-called "double-cross" method (originated at the Connecticut Experiment Station), or several of the best strains may be combined to produce a new variety. Just which method will prove to be the most practical is still to be determined.

This method of breeding may be called "selection in self-fertilized lines." It is being used by practically all the state experiment stations in the Corn Belt as well as several seed companies. The Waseca and Crookston branch stations are co-operating with the Central station at University Farm in breeding corn by this method. Results obtained in

1924 at University farm give much promise for this method of breeding. One double cross yielded 22.9 per cent higher than Rustler, the highest yielding variety at University Farm that year. Other double crosses yielded from 5 to 20 per cent higher than the highest yielding parental variety. While one year's results can not be considered as conclusive evidence, they do support the general belief that our ordinary standard varieties of corn can be greatly improved by this method of breeding.



Strains of Rustler White Dent Corn
These grew in nearby rows which have been self-pollinated by hand for three generations. The strain on the left has sturdy erect stalks, while the one on the right lodges badly.

In general, this can not be considered a method that a farmer can use. It is a long-time proposition and requires considerable labor at corn-pollination time when a farmer is busy with other operations. However, at least one progressive farmer in Minnesota has inbred strains of corn which have been artificially self-fertilized for three years; and it is possible that the future may see several farmers in a single community co-operating in a project to improve a variety by this method, each taking the responsibility for continuing the inbreeding

of a few selfed strains. Such a project would have many things of interest to recommend it to a community aside from the possibility of improvement of the variety or varieties of corn adapted to that locality.

WHICH IS BETTER, BIENNIAL OR ANNUAL SWEET CLOVER?

Not many years ago sweet clover was considered a rank weed. It has become one of the important forage crops of the northwest. It has also great value as a green manure crop in building up soil fertility. The roots of the biennial sweet clover, particularly, store large amounts of nitrogen which becomes available to succeeding crops. Biennial white sweet clover (*Melilotus alba*) and biennial yellow sweet clover (*Melilotus officinalis*) are the varieties commonly grown for hay and pasture. The biennial white has certain advantages for hay and the yellow for pasture. Each has strong advocates. In recent years an annual white sweet clover has been widely introduced which also has certain desirable characteristics.

The agronomy division of the experiment station has grown the three varieties for several years for the purpose of learning which gives the best yields of hay. Comparisons have also been made of the root growth of each variety and of the amount of nitrogen stored while growing. Tests were made at University Farm and at the branch stations at Waseca, Duluth, and Crookston. Data from all tests show that the annual white sweet clover yielded 15 per cent more hay than the biennial white and 35 per cent more than the biennial yellow variety. On the heavier soils at Waseca and Crookston the yields were larger than those obtained at University Farm, where the subsoil is gravelly. While the yields of hay were higher with the annual varieties than with the biennial, the root residue remaining in the soil was approximately only one-fifth as much. The total dry weight of hay and roots combined was approximately twenty-five per cent more with the biennial than with the annual white variety.

There was little difference in the protein percentages in hay of annual and biennial sweet clovers. The protein content of the roots of the annual white variety, however, was much lower than of the biennial roots. The percentage of protein in the annual white roots was 8.4, and in the biennial, 18.3. The amount of protein in the hay and roots combined was 55 per cent greater in the biennial white and 61 per cent greater in the biennial yellow than in the annual white variety.

If an annual or emergency hay crop is desired the same year that it is sown and the effect on the land is a secondary consideration, the greater hay yield obtained from the annual white sweet clover justifies the use of that variety. If the sweet clover is to be used as a pasture crop or for a two-year hay crop, the biennial varieties can be more

successfully used. For soil building, the biennial white or yellow is much better than the annual white because of the more extensive root systems and the higher percentage of nitrogen stored.

WHICH VARIETIES OF SOY BEANS ARE BEST FOR SEED AND HAY?

The soybean crop has an important function in Southern Minnesota agriculture as an annual or emergency hay crop in case of clover hay shortage or failure. It is also a valuable source of protein-rich feed for most classes of livestock. The following table includes varieties which have been tested in Southern Minnesota and shows the yields of seed, straw, and hay for each for three years. (Hay on 15 per cent moisture basis.)

Variety	Seed	Straw	Hay
	Bu.	Tons	Tons
Minsoy	14.96	0.82	1.27
Wisconsin Black	10.91	0.98	1.39
Ito San	12.35	1.29	1.65
Chestnut	14.32	1.18	1.62
Early Brown	13.00	1.30	1.83
Black Eyebrow	11.70	1.09	1.94
Habaro	15.90	1.01	1.83
Manchu	13.65	1.25	1.83
Elton	13.68	1.02	1.53

Minsoy and Habaro, which yielded 15 and 15.9 bushels of seed per acre, respectively, were the best seed-producing varieties. Chestnut, which yielded 14.3 bushels, Elton 13.7 bushels, and Manchu 13.6 bushels per acre, while not quite equal to Minsoy and Habaro, are satisfactory seed-producing varieties. Minsoy and Habaro are desirable when the crop is to serve for hay as well as for seed. Wisconsin Black, Ito San, and Black Eyebrow did not produce satisfactory yields of seed in Southern Minnesota.

The varieties which gave the highest yields of seed did not, in most cases, produce the greatest yields of hay. Black Eyebrow yielded 1.9 tons and Early Brown, Habaro, and Manchu each 1.8 tons of hay per acre. These were the highest hay-yielding varieties. The lowest yields of hay were obtained from Minsoy, 1.3 tons; and Wisconsin Black, 1.4 tons, per acre. These varieties should not be grown in Southern Minnesota for hay. Chestnut yielded 1.7 tons and Elton 1.5 tons of hay. The yields from these two varieties are not the highest, but the quality is excellent. The stems are well branched and fine in texture, a highly desirable quality for a palatable soybean hay. The higher yielding varieties—Manchu, Black Eyebrow, and Habaro—produce coarse and less palatable stems, especially on soils of high fertility.

In general, the varieties that yield the most hay also yield the most straw. Soybean straw is relished by all classes of livestock and should be saved for winter roughage.

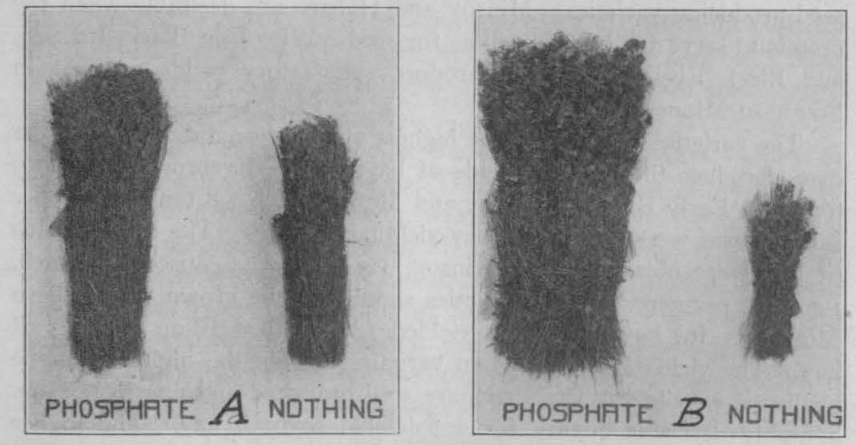
For growth in Southern Minnesota, Habaro, Minsoy, Chestnut, Elton, and Manchu will do best for seed production. For hay production the same varieties with the exception of Minsoy will be most satisfactory. Minsoy is strictly a seed variety. Chestnut and Elton give the best quality of hay.

SOILS

SOIL NEEDS FOR ALFALFA

Alfalfa has a place on every farm where productive livestock is raised. It is regarded as a most desirable cured forage for cattle and sheep. It can be used to advantage in some form for every class of livestock. The growth and use of alfalfa will enable the stock raiser to avoid the purchase of expensive high protein feeds and thus to reduce his feed costs.

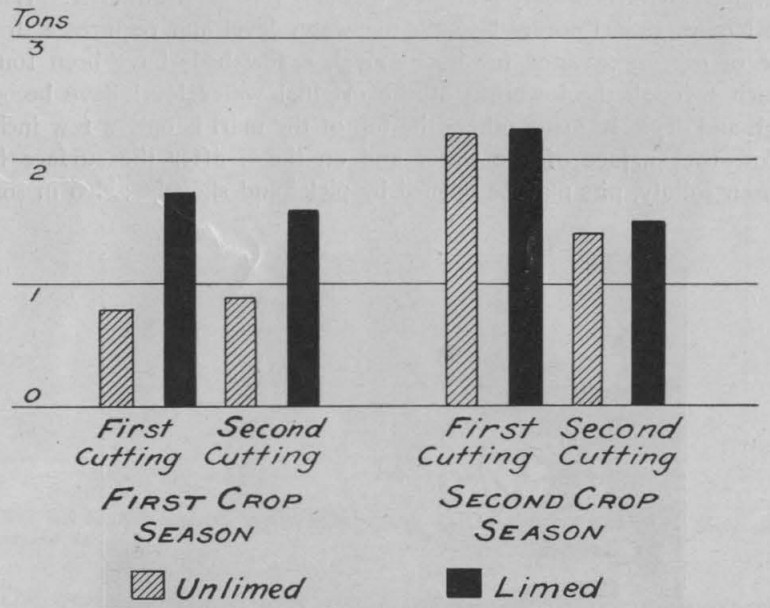
The acreage of alfalfa is increasing rapidly in Minnesota, but much more is needed. Many farmers do not grow it because they have difficulty in getting a good stand. Often failure is due to faulty soil conditions which can easily be amended if the cause is known. The Division of Soils has made extensive investigations of the soils of the state and finds that they vary greatly in their suitability for alfalfa. The treatment that will give good results in one area may not be at all the proper treatment for other areas. The suggestions that follow are from the results of tests and trials in various parts of the state.



Effect of Phosphate in 1924 on:
A, Alfalfa in Lac Qui Parle County; B, Red Clover in Jackson County
Each bundle is from 4 square yards

Phosphate for Alfalfa and Clover in Southwestern Minnesota

In the southwestern and western counties the effect of an application of acid phosphate or treble superphosphate on the common clovers and alfalfa is so generally beneficial that it appears worth while for every farmer in those districts to try small-scale experiments, as on one-fortieth acre plots, on his different fields of legumes. The response to phosphate varies so much from farm to farm, and even from field to field on the same farm, that one is wise not to purchase phosphate in any considerable amount before making inexpensive trials on his fields. Two or 3 pounds of treble superphosphate or 6 or 7 pounds of 20 per cent acid phosphate, is enough for such a plot. A dollar's worth of fertilizer will provide for the plots needed on a farm. If it proves very beneficial on clover or alfalfa, it should be tried on wheat and barley.



Yields per Acre of Alfalfa in 1924 on Kenyon (Foss) Low-Lime Experimental Field
In the second crop season the growth on the unlimed plots overtook that on the adjacent limed land because the roots reached the limey substratum.

"Pickup" of Alfalfa on Unlimed Land in Southeastern Counties

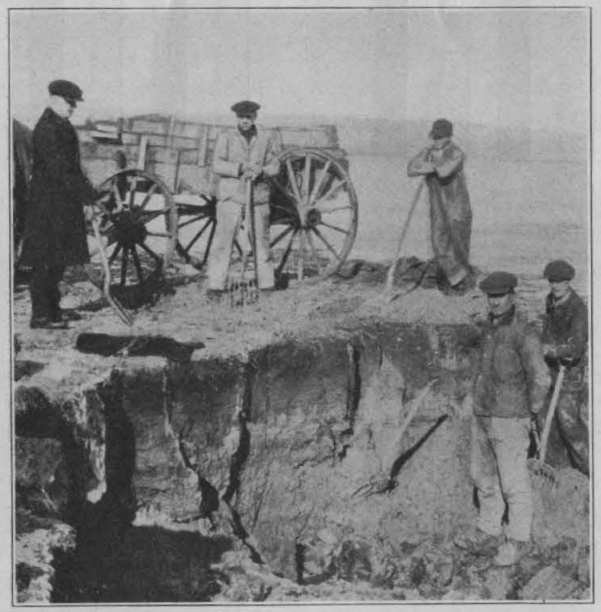
In the nine counties southeast of the Twin Cities most of the soils are decidedly acid and on these alfalfa has usually been found to make poor growth in the second season (the first that it is cut for hay) unless the land has been limed. Over much of this region, however, there is an abundance of lime in the subsoil of the fourth foot and below. At

the Kenyon low-lime experimental fields (Goodhue County) it has been found that if the alfalfa on the unlimed land survives the second winter its roots will get down to the limey substratum, after which the plants rapidly improve. After that the crops yield almost as well on the unlimed as on the adjacent limed plots.

Where the limey layer is first encountered, at 8 feet or more below the surface, as in parts of the extreme southeastern corner of the state, no instances have so far been found where the alfalfa on unlimed land has survived until its roots have reached this layer.

Winter Removal of Marl

Alfalfa gives promise of becoming the most valuable crop on the sandy lands between St. Paul and Bemidji, but usually, to insure success, the land must first be limed or marled. Marl is to be found in hundreds of beds widely scattered through this sandy district. While most of this marl occurs beneath the water level and requires a dragline or other excavator for its removal, a few beds have been found which through the lowering of the original water level have become high and dry. In many others the top of the marl is only a few inches below the surface of the water and on these, after the surface has frozen solidly, pits may be opened by picks and shovels, aided in some

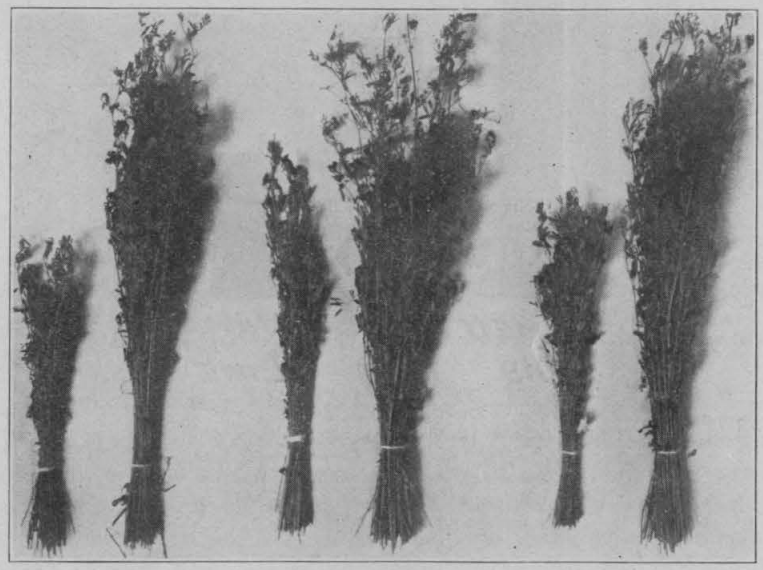


Taking Marl from Perch Lake in February. Surface Frozen Solid

cases by an explosive. Then the marl may be loaded on wagons or sleighs and hauled away without any inconvenience from water flowing into the pits.

Lime Early for Alfalfa

The sooner you do it the better, when you have once decided to apply ground limestone or marl to a field for alfalfa. Sometimes on a lime-deficient soil alfalfa does as well if the application has been made and thoroly worked in just before seeding as if it has been on for several months, but at other times there is a great difference and always in favor of the early liming.

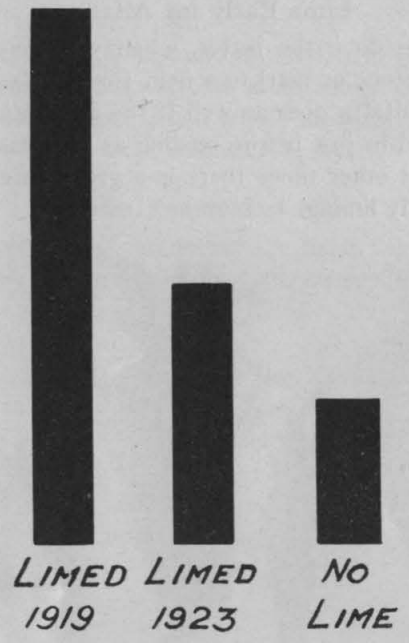


Alfalfa Plants from Unlimed Plots on Same Field in August, 1923

The tall bundles are from five plants whose roots had already reached the limey substratum and the short ones from five whose roots had not yet penetrated so deeply.

The west half of each of 22 plots on the Coon Creek sand experimental fields was treated with 4 tons per acre of ground limestone in May, 1919, and during the following four years all were cropped alike with rye, clover, potatoes, and rye. In 1923, after removing the rye, all the plots were plowed. Ground limestone, at the rate of 4 tons per acre, was applied and disked in on the east quarter of each plot, the remaining quarter of each being left unlimed. The following day, August 13, all were seeded to Grimm alfalfa. A good stand was secured on all three parts of each plot but almost from the start there was a marked difference in the growth and color. The alfalfa on the half

limed four years before was far better than that on the quarter limed just before seeding, while this in turn was superior to the alfalfa on the unlimed land.



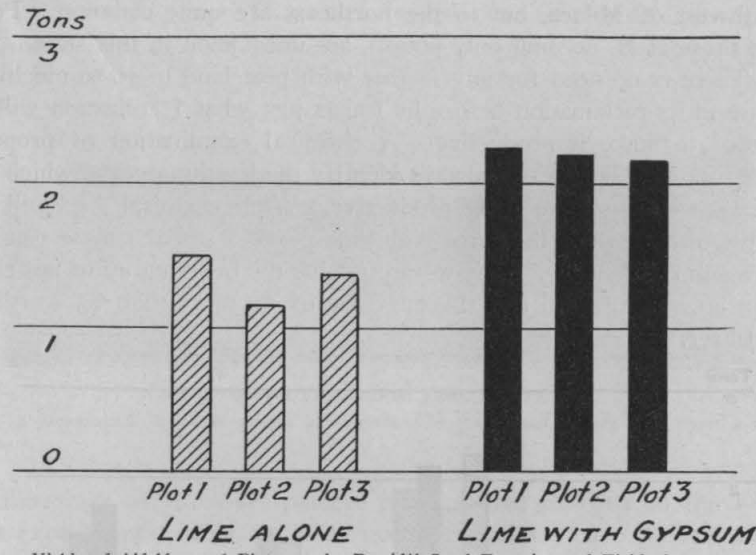
Effect of Early Liming
Relative yields in 1924 of alfalfa seeded in August, 1923, on Coon Creek Sand Experimental Fields—on unlimed land, on land limed the day before seeding, and on land limed four years before.

Sulphur Fertilizers for Alfalfa on Northern Sandy Lands

Alfalfa on the Bemidji sand experimental field showed a marked benefit in 1924 from the application of gypsum, while on the Backus sand experimental field (Cass County) there was a distinct but smaller increase. This benefit is due to the sulphur contained in the gypsum, about one-fifth its weight.

In many other parts of the state experiments with sulphur fertilizers on alfalfa have failed to show any distinctly beneficial effect and their place in Minnesota may be limited to the northern sands and on these to alfalfa, a crop which is particularly sensitive to a lack of sufficient sulphur in the soil. It appears worth while for farmers with alfalfa on such soil to try small plots with either sulphur flour or gypsum. Five pounds of the former or 25 pounds of the latter is sufficient for a trial plot 2 rods square—one-fortieth acre.

Gypsum can not take the place of lime, and on sands where it is needed for alfalfa, ground limestone or marl should be applied in advance of gypsum or sulphur.



Yields of Alfalfa on 6 Plots on the Bemidji Sand Experimental Fields in 1924
All had been limed but only the three had been treated with gypsum—a sulphur fertilizer.

GETTING RESULTS FROM PEAT LANDS

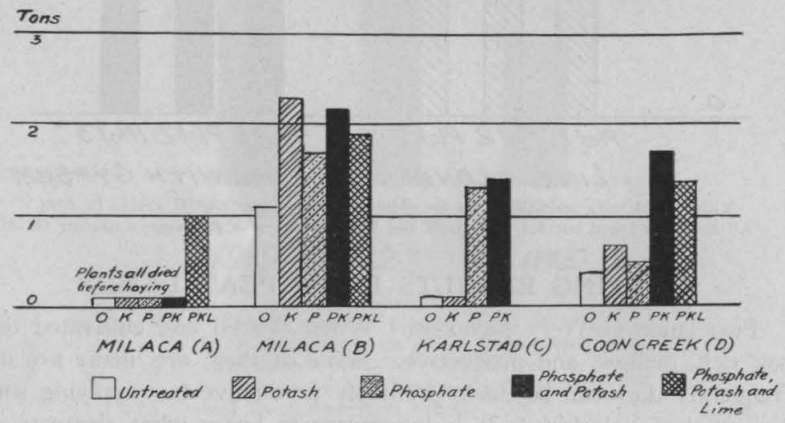
Peat lands are very deceptive. When cleared and cultivated they look rich, mellow, and productive. Some of them are, many are not. Frequently they can be made profitably productive by supplying some element that is lacking. It is imperative to know what elements are lacking if good crops are to be grown. It is well also to know how they can best be supplied.

Four Peat Experimental Fields, No Two Alike in Fertilizer Requirements

The experiment station operated four peat experimental fields in 1924. On one (A), 10 miles north of Milaca, all farm crops failed except where limestone or marl had been applied, and even then growth was very poor unless both potash and phosphate as well had been added. On the second (B), at Milaca, the addition of potash alone was sufficient, the plots treated with this yielding as well as those given lime, phosphate, and potash. At Karlstad (C), only phosphate was found deficient, while at Coon Creek (D), both potash and phosphate were needed but liming was without benefit. Karlstad is in the northwestern corner of the state and Coon Creek 20 miles from St. Paul.

Peats like that at D are those usually met with south of Milaca, while those of the northwestern part of the state are nearly all like that at C. Low-lime peats, like those at A, are very rare south, west, and northwest of Milaca, but to the northeast are quite common. Peats like those at B, needing only potash, are uncommon in this state.

There is no need for any farmer with peat land to go to much expense in its reclamation before he learns just what fertilization will be needed to make it productive. A chemical examination of properly taken samples will nearly always identify the low-lime peats, which are the most expensive to make productive. While chemical tests will not distinguish between the three high-lime peats, a set of simple plot experiments will suffice. This would involve the breaking up of not more than an acre of land and the purchase of no more than $5 worth of fertilizer.



Yields of Hay on Four Peat Experimental Fields in 1924

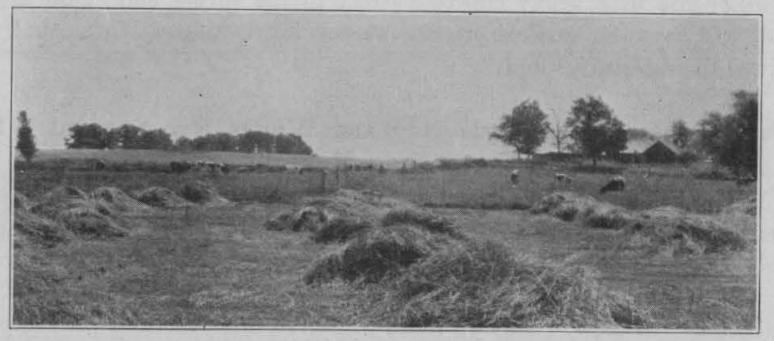
At Coon Creek it was timothy, seeded in 1919, and on the other three fields clover and timothy seeded at the end of May, or early in June, 1924. At Karlstad the peat is so rich in lime that no liming experiment was included. At A the death of the plants was due to lack of lime.

Pastures on Peat

Peat soils properly drained and fertilized provide excellent bluegrass–white clover pastures, equal in quality and carrying capacity to those on many of our best mineral soils.

At Coon Creek, land broken in the fall of 1922 was seeded in 1923 to bluegrass and white clover with a little alsike and timothy. Both potash and phosphate fertilizers were used. Two acres of this was divided, by fencing, into four half-acre pasture plots, which in 1924 were pastured from June 3 to October 10 with heifers weighing from 310 to 900 pounds. During part of this period 12 animals were used; and during the rest, 6. The two acres provided 1133 days of pasturage

with an average daily gain of 0.7 pound—793 pounds in all. If we assume that a cow would have eaten as much as two of the young animals the two acres would have been sufficient for two cows for 284 days.



Coon Creek Peat Experimental Field, July 17, 1924

In background, cattle in pasture experiment. In foreground, clover hay, about 4 tons per acre.

Bluegrass–white clover pasture plots, seeded in 1919 on the Fens peat experimental fields, 50 miles north of Duluth, have proved satisfactory in each of the five years they have been under trial.

Cattle in Pasture of Alsike, White Clover, and Bluegrass on Fens Peat Experimental Fields, July 15, 1920

For best results the average water table should be about 30 inches below the surface, so that the land is firm enough to bear the weight of the pasturing animals and still provide plenty of moisture during dry periods. If the water is much higher the surface is liable to become hummocky, while if it is too low the growth will be light during dry periods. It is better to have the water table too deep than too near the surface.

The first fertilization should be the same as for hay but after the first season it is not necessary to use so much phosphate or potash because a large part of these will be left on the fields in the excrement of the pasturing animals.

The use of a heavy concrete roller in the spring and again in the fall will firm the surface, flatten hummocks starting to form, and improve the moisture supply.

On Northern Peat Lands Hay and Winter Rye Succeed When Summer Frosts Ruin Many Other Crops

Our northern peats, where farmed, had best be devoted largely to clover and timothy for hay and to bluegrass and white clover for pasture. Winter rye is the surest grain crop.

On account of summer frosts, the season of 1924 was very unfavorable for many crops on these soils. At the Karlstad peat experimental field (Kittson County), 30 miles south of the Canadian line, oats, barley, and flax failed, owing to frosts in July and August, while the clovers and grasses were uninjured. On plots fertilized with phosphate, a mixture of alsike and medium red clover seed on May 31, 1924, and cut in September gave 1.34 tons per acre of cured hay; and a mixture of the same clovers with timothy, seeded and cut on the same dates, gave 1.28 tons. On the corresponding unfertilized plots the plants were too short for hay.

Clover Hay at Golden Valley, July, 1922

Cock at left from phosphate-treated plot; the one on right from unfertilized plot of same size.

There was no winter rye on the Karlstad field, but on similar peat on the Golden Valley peat experimental fields, about 50 miles to the southeast, it yielded 23 bushels per acre on phosphate treated land.

The experimental work was discontinued on the Golden Valley fields with the close of 1924, and transferred to those at Karlstad.

YIELDS PER ACRE OF HAY AND RYE AT GOLDEN VALLEY

Year	Rye		Timothy and clover hay	
	With phosphate	Unfertilized	With phosphate	Unfertilized
	Bu.	Bu.	Tons	Tons
1919	23.5	3.4	2.39	1.42
1920	19.9	2.8	1.57	0.00
1921	34.5	9.6	1.57	...
1922	27.3	8.5	3.94	0.43
1923	27.1	7.2	1.49	0.16
1924	22.9	3.5	1.37	...

Winter Rye on Fertilized Plot on Golden Valley Peat Experimental Field, July, 1921

HORTICULTURE

WHICH IS THE BEST STRAWBERRY?

Strawberries are native to Minnesota. Nearly everyone likes them. They are easy to grow if you know how. In the aggregate, many acres of strawberries are grown in the small garden patches of Minnesota. They are an important garden crop. But not all strawberries are good strawberries. It may be just as difficult to find the best strawberry as it is to find the best breed of cattle or the best wife, but it is worth while if it can be done.

At University Farm continuous tests are made of the new varieties introduced. From twenty-five to forty June-bearing varieties, and from ten to eighteen of the everbearing strains are grown in comparative test plots annually. The list of varieties changes as new varieties are brought in and the poorer ones discarded. Many new varieties are de-

veloped at the fruit-breeding farm and by commercial growers. Not all the varieties tested at University Farm will do equally well on different soils and under different climatic conditions. Comparisons can be made, however, that will be of value to berry growers everywhere.

In row development, the best stands have been obtained with Minnehaha, Nokomis, and Easy Picker. Dunlap, Lovett, Parson's Beauty, and Stevens Late have also made good rows. Chesapeake and Big Late have generally made poor rows. Premier has sometimes not developed good rows but usually makes a satisfactory stand.

In yield, Easy Picker has led, Chaska, Minnehaha, and Dunlap also yielding well. Premier has not produced satisfactory crops at University Farm, but yields very well in some other localities.

The earliest maturing June fruiting varieties have been Premier and Campbell's Early, with Marshall and Chaska only a day or two behind. Best, Chesapeake, and Big Late are the latest to ripen, but Easy Picker and Nokomis have held over into the late season with fairly good picking. Minnehaha, while not the latest to ripen, seems to be the best late variety from the standpoint of yield and shipping quality.

Premier and Minnehaha have been the firmest in texture and are thus well suited for shipping. Very good shipping varieties are Dunlap, Gibson, and Marshall. In surface color, Chaska, Collins, Dunlap, Eaton, Minnehaha, Premier, and Parson's Beauty have been the best.

In flesh color, Chaska and Easy Picker have led with Dunlap and Mascot nearly as good.

Based on general performance values, a list of varieties for commercial planting in Minnesota, arranged in approximate order of ripening, should include Premier, Dunlap, Chaska, Easy Picker, and Minnehaha.

Of the everbearing varieties, none have been found to equal the average June-bearing varieties in yield. The everbearing varieties are chiefly valuable for the extra earliness of the June crop and for special markets in the fall, or for home use. Progressive and Duluth are the most satisfactory varieties. Several new varieties, as Champion, Deephaven, Kosata, Lucky Boy, Neverfail, and Peerless, are worthy of further trial.

DO YOU WANT TO GROW GOOD POTATO SEED STOCK?

The production of good potato seed stock is an important branch of the potato-growing industry. It is becoming a large commercial interest in Minnesota. Northern grown, disease-free stock is very popular in the South and brings good prices. In the northern states it is quite as important to plant disease-free stock as in the South and the large growers of potatoes are insisting more and more on clear, disease-free, certified stock. It is estimated that Minnesota growers

last year produced 777,800 bushels of high-grade disease-free potato seed.

It is generally believed that potato stocks run out. No one has yet been able to prove that they run out when attention is given to selecting good seed stock and when diseases are kept out and good care is given the growing crop. During the last few years the Agricultural Experiment Station has given attention to testing seed stocks of various kinds and to studying the factors which cause seed potato stocks to decline in value.

During this period the horticultural division, in co-operation with the branch experiment stations at Duluth, Grand Rapids, and Crookston, and with the State Department of Agriculture, has been studying the requirements for the production of desirable seed potato stocks. Seed stocks have been obtained from growers of certified potatoes in various parts of the state and grown at University Farm and the branch stations under comparable conditions.

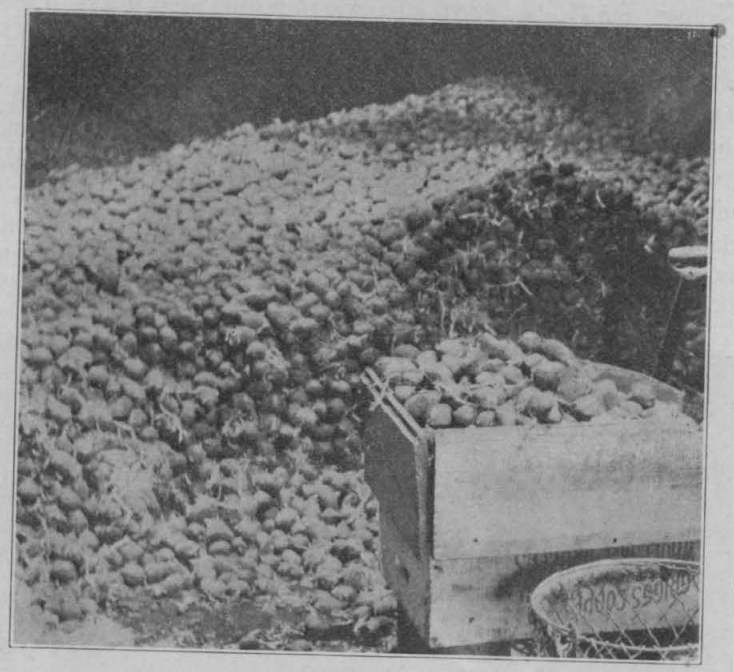
A bin of well kept potato seed stock. The tubers are in excellent condition. There has been no loss of plant food, thus insuring quicker germination and even, vigorous growth when planted.

These studies have shown that satisfactory seed stocks can be produced in all the principal potato growing sections of the state. Both soil type and climatic conditions appear to be favorable in all these regions. The stocks furnished by growers from the different sections were grown in comparative yield tests. The yields were uniform and indicated no large advantage from any special section.

The largest factor involved in the production of seed potato stocks is freedom from disease.

Growers who plant disease-free stock, who rogue out and destroy all diseased plants as they appear, and who spray for diseases and insects, invariably produce the best seed stocks.

Winter storage also influences largely the condition of the seed stock at planting time and the quality of the crop produced.



Potato Seed in Poor Condition

The stored plant food has been partly exhausted and the vitality lowered by sprouting. As a result the germination when planted will be slow and the growth uneven.

Sprouting and tuber rot development lower the vitality of the stock and should be prevented by sanitary measures and by controlling the temperature of the storage space.

Other sources of loss are cutting seed tubers too long before planting (causing overheating or the development of rot) or drying out. Good seed stock can not be produced without attention to all the small details of production and storage. Such attention when given will be rewarded in better prices for the stock when sold.

EFFECT OF SOURCE OF NURSERY STOCK ON APPLE TREE GROWTH IN MINNESOTA

Minnesota needs winter-hardy fruit varieties. The statement applies to tree fruits as well as to small fruits. It applies particularly to apples. The common method of propagating apples is to bud on to French crab seedlings. Usually when planted some of the stock remains at or close to the surface, where winter injury may occur. When whole roots are used for grafting the same undesirable condition may be obtained. When piece roots are used with long cions, the root of unknown degree of hardiness is certain to be set deeply in the soil where winter injury is hardly to be expected and hardy roots will develop from the cion. In late years the practice has developed rapidly among Minnesota nurserymen of growing seedlings from hardy apple or crab varieties instead of the French crab seedlings for use in propagating. Wherever such hardy seedlings are used there is a high degree of probability that a hardy variety will have a hardy root regardless of whether the propagation is by bud or root grafting.

It has been a common belief among Minnesota apple growers that in order to secure a sufficient degree of hardiness in apple stock it must be obtained from nurseries situated in the North. It has been believed that all nursery stock of southern origin would be of doubtful hardiness. The subject has often been debated at meetings of the Minnesota Horticultural Society and it has been emphasized in the selling campaigns of local nurseries.

In order to determine the behavior of trees grown from stock from various places, the horticultural division of the experiment station started an investigation in 1916. Ten trees each of Duchess, Wealthy, McIntosh, and Jonathan varieties were obtained from nurseries in Minnesota, Missouri, Alabama, Oregon, New York, and Maryland. These four varieties were selected as offering a range in hardiness among the kinds more or less commonly found in Minnesota orchards. An effort was made to obtain trees of uniform age and propagated in the same way. This was not found to be possible, however, owing to differences in nursery practices in the several states. From New York, Maryland, Alabama, and Oregon, two-year-old budded trees were obtained. From Missouri, the Duchess and McIntosh trees were one-year budded trees and the Wealthy and Duchess trees were two-year grafts. The Minnesota-grown trees were three-year grafts. In all cases the trees were propagated on French crab roots. The Minnesota-grown trees were not so large or in as good condition as the others.

The orchard until the present time has been kept for the most part under cultivation. Because of crowding it was necessary to remove a large part of the trees in 1920. All the Jonathan trees died or were so

badly winter injured that they were of no value. In 1920 another block of Duchess trees were planted, 15 trees coming respectively from two nurseries in Minnesota, one in Missouri, and one in Maryland. The trees from Missouri were budded on French crab roots, but the others were all grafted on the same kind of stock.

Estimates of comparative vigor and size of the different blocks of trees planted in 1916 have failed to indicate any significant difference in the behavior of the trees from different sources. In no case have the Minnesota-grown trees ranked better than third, and they have been rated fourth and fifth in the annual examinations. To the casual observer there is not enough difference in the trees to lead him to believe that they were not originated from the same nursery. Estimates of the set of green fruit have shown no appreciable difference in the behavior of the trees from different sources.

After growing for five years in rows side by side, the trees planted in 1920 were generally uniform in appearance and vigor. Variations among the trees from any one source were as marked as those from different sources. Six of the Missouri trees had died from root injury and one tree from each of the Minnesota nurseries died from the same cause. Samples of fruit were produced by the most vigorous trees grown in 1924. There was no difference with respect to the fruit grown which could be ascribed to the sources from which the trees were obtained.

The obvious conclusions that can be drawn from these experiments are (1) that the behavior of a variety in a locality does not depend upon the place where the nursery stock was grown. (2) The hardiness of French crab roots is generally too uncertain to warrant their use in Minnesota unless so handled in the nursery propagation that they may be set deeply in the orchard soil, thus escaping winter injury. (3) It is evident that hardy roots are as necessary as hardy tops for successful growth in Minnesota.

Hardy roots are as necessary as hardy tops for successful growth in Minnesota.

DESIRABLE NEW VARIETIES OF VEGETABLES

Vegetables form an important part of the family diet. The use of vegetables as food can be greatly stimulated by growing those of good quality. There are wide differences in quality of the various varieties. Not all are adapted to Minnesota conditions. Tests of the growing habits and yields are advisable in finding the best. Comparisons of quality and food value are also necessary. The Minnesota Agricultural Experiment Station annually conducts tests of the new varieties offered. Those described below have proved to be valuable additions to varieties grown in Minnesota.

Golden Acre cabbage is a new early variety of the round-head type. It matures practically as early as Jersey Wakefield, has a more solid head, and will produce a much larger percentage of marketable heads than will the Jersey Wakefield.

Mary Washington asparagus is the best of the Washington type. It is extremely resistant to rust, is superior to many of the old strains in earliness, vigor, yielding ability, and length of shoot.

Ebenezer onion has been grown in certain sections of the East for a considerable length of time but only in recent years has its true value for other sections been realized. It is a pure yellow and flat type. Ebenezer is an excellent set onion, ripens down well, and is a splendid keeper.

"Kitchenette" Hubbard is a small edition of the Hubbard squash developed at the Minnesota station. It averages about five pounds per squash, but yields as heavy a tonnage as any of the Hubbards. It is the ideal squash for the small family.

Des Moines, or Table Queen, squash is becoming quite popular among Minnesota gardeners. This is a small acorn-shaped squash, 5 or 6 inches in diameter.

Collection of Des Moines Squash

They are often called "Table Queen." They are fine edible squash, making an ideal serving in the half shell.

Thomas Hybrid, or Improved Milwaukee Market, is a very superior muskmelon for the home garden or a direct producer-to-consumer trade. This is a salmon fleshed melon of excellent quality.

Burbank tomato is a selection from the Welkman Earliana variety developed by Luther Burbank. It is smoother in appearance and somewhat more uniform in type than the parent variety. These characters, coupled with its earliness and productivity, make it a desirable acquisition for both the home and the market gardener.

VEGETABLE CROPS ON PEAT LANDS

Great advances are being made in reclaiming and cultivating the peat lands. Many inquiries as to the management and cropping of such lands are made but little information is available.

In order to obtain information on the commercial production of vegetables on peat land, several lines of experiments were made at Fens in St. Louis County in 1924 by the horticultural division of the experiment station. These experiments covered: (1) The determination of the vegetable crops most suitable and the particular varieties best adapted to the peat soils of northern Minnesota, (2) Studies of the fertilizer requirements of the various vegetable crops and the reaction of these crops to varying amounts of phosphate, potash and nitrogen, and of the value of commercial fertilizers compared with barnyard manure, alone or in combination, (3) The relation of the water level to the growth, development, and quality of the various crops and the effect of the water level on frost injury. The water level was maintained at 12, 18, 24, 30, and 36 inches, respectively.

While one year's trial is not sufficient to warrant final conclusions as to these varieties, it is believed that the tests for 1924 are representative of the results likely to be obtained on peat land in seasons similar to that of 1924. On the basis of this one year's trial, the following crops and varieties are suggested for peat lands in northern Minnesota.

Results with Fertilizers

The application of nitrogenous fertilizers to vegetables on peat land gave no appreciable increase in yields. On virgin peat land a light application of phosphate alone hastened maturity and produced plants with reduced vigor. A light application of potash alone resulted in slow and unsatisfactory development of plants. Phosphate and potash in combination gave better results than either alone. An application of from 250 to 300 pounds of superphosphate and 300 to 600 pounds of muriate of potash per acre is suggested as suitable for most crops.

Effect of Water Level

There was little or no injury to potatoes and corn from light summer frost when grown on land where the water table was high, i.e., close to the surface. On the drier plots or where drainage was deeper, from 75 to 95 per cent injury was observed.

Celery stalks on the most deeply drained land averaged slightly heavier than on the wetter land.

Cabbage was first ready for use and the heads and plants were slightly larger on the land where a 24-inch water level was maintained.

Cauliflower did best on land where the water level was high.

The largest heads of lettuce were harvested from the plots where the water table was high. Those from the more deeply drained plots were equally firm, tho smaller.

Carrots from the land where the water was maintained at 24 to 30 inches below the surface were of the most desirable shape, being longer and smoother than those from the plots where the water table was high.

Onions germinated better and made more rapid growth on the plots where the water table was high.

Observations on this year's growth indicate that the reaction to height of water table is not the same for all vegetables. Further experimentation will be necessary to secure conclusive evidence as to the effect of the water level on various crops.

Celery grows in excellent form on the peat lands. It is rapidly becoming an important commercial crop on the peat soils of Minnesota.

Cultural Methods

In the preparation of the land a tractor was found to be more effective than double disking with horses, the greater speed of the former being invaluable for pulverizing the peat. Rolling with a heavy roller and dragging with a plank drag prior to seeding, are valuable practices for facilitating seeding and providing a good seedbed. The best results followed the use of the knife attachments on the cultivator for such

crops as celery and lettuce, which are surface feeders. Cultivation should be shallow and frequent to control weeds and to permit proper soil aeration. Where the water table was high, raking the weeds out and removing them from the land was found to be the only satisfactory method of control. When left as they fell behind the cultivator they took root and made new growth within a day or so.

FORESTRY

Windbreaks

There is a crying need for windbreaks in certain parts of the state. Not only in the prairie sections, but also in some cut-over sections which were at one time heavily timbered.

Windbreaks are not luxuries, as many seem to think, but necessities if the farm is best to fulfil its two most important functions—producing crops and making a comfortable home. They stop the incessant howling of the wind and the blowing of dirt which is so often the bane of the housewife's life. They reduce the fuel bill and do away with much of the discomfort of outside winter chores. Those who live behind a good windbreak never know how cold it really is outside of it.

Windbreaks are not luxuries; they are necessities.

Even to those farmers who are interested solely in the success of their crops and to whom the comforts of life have no appeal (far too large a proportion, by the way) the windbreak should have a real appeal. It protects the stock as well as the family. Less food is required to keep them in condition; they will be healthier and put on more weight.

Crops also will benefit from a shelterbelt along the edge of a field. Because there is a narrow strip close to the trees where grain does not head, many farmers object to shelterbelts. They say it reduces the size of the fields and that the snow lingers in the spring and prevents them from plowing there as early as elsewhere. That is true, but it has been shown that the increased crop on the rest of the field more than makes up for the lost space, and because the snow lingered there in the spring a seed crop has more than once been produced there when the rest of the field was an utter failure.

Windbreaks must be far enough away not to drift the snow around the buildings—about a hundred feet will do it—properly spaced to intercept the wind and composed of the right kind of trees rightly taken care of. Fulfil all these conditions and windbreaks will be a decided blessing.

Demonstration windbreaks planted by the University in 54 counties have brought out some interesting facts. Probably the most important is the assurance that windbreaks can be successfully grown practically everywhere in the state. Of the hardwoods, white elm, green ash, Russian olive, caragana, and boxelder have proved most satisfactory. Of the evergreens, white spruce is the best.

Only in certain alkaline soils have any of these trees failed and even there the Russian olive, caragana, and boxelder will do fairly well.

Cultivation is one of the most important factors in a successful plantation. With the conifers, cultivation often means the difference between success and failure. With the hardwoods, lack of it may not mean death, but it does mean, every time, a greatly reduced rate of growth.

A young windbreak of pines and spruce makes an excellent windbreak.

Out of 250 windbreaks which have been planted and given only reasonable care, 99 per cent of the hardwoods have lived and 83 per cent of the evergreens. That means that very few farmers in the state need be without windbreaks because they will not grow.

Don't envy your neighbor. Get some good stock, plant it right, cultivate it as you do your other crops, and you can soon have a good windbreak of your own.

Second Growth on Cut-over Lands

There are more than 14 million acres of cut-over land in Minnesota. The value of that land as well as the future timber supply of the state depends largely upon what is now growing on the cut-over land. With

a view to estimating the timber growth on the cut-over lands, a survey of such lands in Lake County was made by the Division of Forestry.

Lines were run through the different types of land as they were classified by the State Geological Survey according to surface formations, and an intensive study was made of certain selected forties by means of sample plots.

The object of the survey was to determine the character and amount of second growth timber.

Some interesting points were brought out. Only one per cent of the entire cut-over area was found to be altogether barren. That does not mean that there was a satisfactory stand of young growth on the other 99 per cent. In fact, slightly more than half of the cut-over land had too scant a growth of young trees to produce a satisfactory stand of timber. Nor are all the satisfactory stands of the more valuable coniferous species; on half of them, birch and popple make up the bulk. These trees are considered of little value at present, but they have their uses and will be considered much more valuable when the species now used are no longer available.

It is comforting to know that there is at present a satisfactory stand of second growth of some kind on approximately half of the cut-over lands in Lake County.

The survey also emphasized very forcibly the necessity for fire protection. It was found that altho one light fire does not necessarily prevent coniferous reproduction, two such fires are usually fatal to it, and three fires begin to affect the rate of growth and density of even the popple and the birch.

The survey also demonstrated that Lake County would always be predominantly a forest region.

Planting Studies

Many years ago it was apparent that many thousand acres of forest planting would have to be done in this state, yet no one knew whether it would be possible to plant with cheap seedlings, or whether it would be necessary to use the more expensive transplants.

In order to solve the problem for jack and Norway pine lands, half-acre plots were planted with seedlings and transplant stock at the Cloquet Forest Experiment Station ten years ago.

The result of the ten-year count on these plots shows conclusively that 2-2 stock (i.e., two-year-old seedlings held for two years in the transplant beds) gave the highest survival and the highest rate of growth.

Other plots showed that plantings of both white and Norway pine could be relied on to survive for at least ten years under dense stands

of jack pine. They do not grow well under such conditions, but the practice would be valuable in establishing these species on jack pine land and would give them a needed start on the faster growing jack pine reproduction when the original stand of jack pine is cut.

On one plot of mature jack pine under-planted with white pine in 1913, the original stand was cut and the white pine released in 1924.

Ninety per cent of the white pine had survived and had attained an average growth of three feet. Some trees were nine feet high and others only one.

Still other plots showed that fall planting can be made as successfully as spring planting if moisture conditions are good, but moisture conditions are less likely to be good in the fall in this climate.

Forestry Practice Will Yield Good Profits

The cutting of a forty-acre tract of mixed Norway pine, jack pine, and hardwoods in the Cloquet Forest Experiment Station demonstrated the possibility of scientific forestry treatment of such land at a profit.

Seventy-two thousand feet of logs, 60 cords of pulpwood, and 100 cords of firewood were taken from the tract and sold at a profit of $1058.46. The tract was left in better condition after the cutting than it was before and a second cutting can probably be made in about fifteen years.