

BIENNIAL REPORT

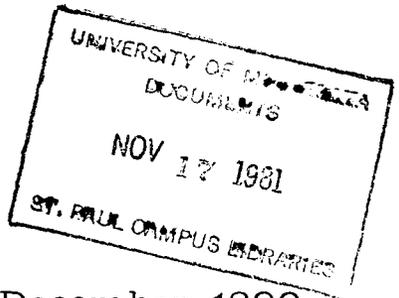
OF THE

MINNESOTA

STATE AGRICULTURAL

EXPERIMENT STATION

FOR THE



Biennial Period Ending December, 1890.

MINNEAPOLIS:
HARRISON & SMITH, STATE PRINTERS.
1891.

Hon. H. H. Sibley, President, and Gentlemen of the Board of Regents:

I have the honor to present herewith a report of the work done at the Minnesota State Agricultural Experiment Station during the years 1889 and 1890, together with other matters of interest to your board.

Very respectfully,

N. W. McLAIN.

Director

St. Anthony Park, Minn., December, 1890.

REPORT OF DIRECTOR.

Upon beginning my duties as director of this Experiment Station in April, 1889, I found the tillable land of the Experimental Farm in a good state of cultivation.

The buildings were in good condition, except the need of painting. I found most of the inside cross fences in good repair. Most of the outside line fences have been rebuilt.

A substantial fence made of cedar posts, boards and wire, has been built along the south line of the farm, as well as along the line of the farm south of the forty acre tract under lease. Other line and cross fences have also been rebuilt, the stock lots and barn yards have been more conveniently arranged, and the fences made are of substantial and permanent kind.

The corn-crib and hog-house have been removed to a new and better location.

The wagon and implement shed has been removed from the north side of the barn, and rebuilt with a shingle roof in a more convenient location on the south of the barn. The old material, with new posts and shingles, was used in making a useful and substantial fixture.

An old cattle shed and old board fences have been taken down and the material used in connection with some new lumber for lining, and new shingles for the roofs, in building two warm hog-houses, suited for experimental pig feeding. These are convenient, much needed and permanent fixtures. They furnish quarters for one hundred head of swine.

The south part of the barn adjoining the farm house has been remodeled, at a very small cost, into commodious and comfortable rooms, three in number, for the use of the entomologist and botanist.

The two rooms in front are used for museum, library and office, and one for storage and for breeding cages. Some slight changes have been made in the back part of the farm house, which necessitated but a small outlay.

The small boiler and engine in use at the barn I found in such condition that it seemed best to exchange it for a fifteen horse power boiler and engine. This was done, the cost of making

the exchange being one hundred and twenty-five dollars, besides the labor of setting the engine, shafting and machinery, done by students employed on the farm.

This power, which is nearly as good as new, is needed for cutting hay and corn fodder, for threshing grain, for cutting ensilage, for grinding feed and for pumping water, and from this boiler the steam for driving the engine in the creamery is supplied, and the waste steam is used for cooking food for pigs. Some changes in the barn have been made at small cost. By simply changing the inner arrangement much more room is secured in the stables.

In order that the School of Agriculture might be furnished with necessary accommodations and with suitable equipment for giving practical instruction in dairy and creamery work—the money needed in building a building suitable for such purposes not being available—the rooms formerly occupied by the entomologist and botanist in the south end of the south wing of the barn, have, at small expense, been converted into a creamery, and an equipment of new machinery, of the latest and best kinds, has been secured at very little cost.

We are under much obligation to Mr. P. M. Sharples of West Chester, Pa.; to Messrs. Cornish, Curtis & Green, of Ft. Atkinson, Wisconsin; to Messrs. Shoudy and Miller of Rockford, Ills.; to Messrs. F. C. Austin & Co., Chicago, Illinois; to the Diamond Mill Manufacturing Co. Owatonna, Minn., for a large mill; to Messrs. Rice & Whitaker, Chicago, for a large steamer; to Plano Harvesting Co., for self-binding harvester; to Mr. T. W. Harvey, of Chicago, Ills., for automatic mowing machine, and to other manufacturers and dealers for most liberal donations, and concessions from wholesale manufacturers' prices, as well as for the favor shown us in making specially designed fixtures and devices suited to our special uses. Most of the machinery and fixtures required in a first class modern creamery outfit suited to the purposes of instruction and experimentation, including engine, milk vat, cream vat and can for the Boyd method, cans and tanks for the Cooley submerged and deep setting methods, power and hand butter workers, power and hand churns, the latest improved De Laval Turbine and Belt Power Cream Separator, &c., &c., are already secured, and the value of the donations is double the sum of the expenditures.

We are also under much obligation to those breeders and dairymen in Minnesota and Dakota who have loaned to this station, for the purpose of experiment and instruction, valuable

dairy cows. These cows not only furnished milk for experimental purposes and for instruction in dairy and creamery work, but also the cattle for experimental feeding; and they also served as types of dairy cattle for the purpose of instruction and illustration.

I am pleased to report to the board of regents that there is a demand for this kind of instruction, and that it will be necessary to furnish more commodious quarters for the classes in dairying.

A hay silo has been built for the purpose of making experiments in curing and preserving clover. This is a substantial and permanent building, costing less than three hundred dollars.

The barnyards were without drainage. Considerable labor has been expended in making surface and underground drains, and in gathering and drawing stones from the pasture fields for filling the surface drains. Grading and filling the ground about the station office building also required considerable labor.

Upon taking charge of the station, April 15th, I found the season well advanced and very little work had been done in the way of preparing the farm land for planting. With one exception the teams were so nearly worn out that they were poorly adapted to farm work, and it was only by great care and diligence that it was possible to remove the large quantities of manure from the barnyards, and plow the land and plant the crops in season. The lack of good horses has been a serious hindrance.

FARM CROPS.

In 1889 about twenty acres were cultivated in oats, thirty acres in corn, two acres in roots, beets, carrots, &c., one and a half acres in potatoes; and fairly good crops were harvested. About sixty acres were mown for meadow. The cultivated crops were much injured by drouth, and the hay was about a full half-crop. Half the thirty acres of corn fodder were put in stack, and about one-third put in silos.

Besides the cultivation of ordinary field crops experiments were made in methods of cultivation, in the varieties of corn best suited for ensilage, in originating and developing new varieties of corn by cross-fertilization and selection, in different methods of sowing clover, peas, &c., in growing varieties of beets for feeding, and in growing buckwheat, beans and millet, and other crops for forage and grain.

During the past (1890) season the work in the Division of Agriculture has included not only the continuance of those lines of experiment which in the nature of things continue from year to year, in order that data valuable for comparison may be obtained, but also new features of work not before undertaken have been begun.

NEW LINES OF WORK.

Among the new lines of work may be mentioned the experiments undertaken in different parts of the state, to discover if possible what fertilizers may be used and what practice adopted to restore to fertility and profitable productiveness the lands exhausted by long and continuous use in wheat growing.

This work has been undertaken in widely separated localities, so that a variety of conditions may be covered, and the soil selected is that best suited to the work.

To be of practical value experiments of this sort must be repeated, and the results obtained from a series of trials tabulated and preserved for comparison.

Experiments have been continued with a great variety of grasses, a great many varieties of corn, with leguminous plants and root crops.

Mixtures of oats and peas of different varieties and of different relative quantities have been sown under similar and unlike conditions.

Root pruning, listing, deep tillage and surface tillage for corn together with tests of varieties have been continued. About forty acres of corn were grown on the station farm. The first planting was completed in good season with the land in fine condition. A protracted period of very wet and cold weather followed and the seed rotted, hence the second planting was late, still there was promise of an unusually large yield. However, the entire crop with the exception of that used for ensilage was so badly damaged by frost that it is impossible to estimate its value or to tell even approximately the number of bushels. I have been making use of this soft corn as best I could in feeding it to hogs and cattle before it should sour or freeze.

One hundred and fifty tons of ensilage from dent, mammoth sweet and ensilage corn were put in the silos in fine condition, and the quality of the ensilage now in use is of the best. About fifty tons of roots, turnips, mangel-wurzels and sugar beets were grown on the farm and stored in our root cellars.

The small acreage sown to oats produced a good crop—635 bushels—the season, and the quality of soil in which the oats were sown, taken into the account. The hay crop on the farm was only fair for the acreage. The yield was thirty-seven and one half tons.

The potato crop was a failure, owing to rotting of the seed during the cold, wet weather succeeding planting. Only twenty-four bushels of good potatoes were produced.

ANIMAL INDUSTRY.

In the line of animal industry, several kinds of work have been undertaken, and are now progressing satisfactorily, and give promise of results of great value.

I have secured for the station a valuable stock of hogs, suitable for breeding and feeding experiments, at a very low price, the breeding, individual merit, and number of animals considered.

I have now in use six different breeds of swine and five different crosses of these breeds.

A careful study of the characteristics of the different breeds of swine, sheep and cattle, and their adaptation to the conditions to be met in producing meat product for profit, in this state, is experimental work full of significance to those engaged in this industry.

No one breed has a monopoly of excellence. Certain excellent qualities and characteristics may be found in certain breeds, in a superlative degree, while in that same breed undesirable and inferior qualities and traits may be found.

Some breeds are more prolific than others, some produce a better quality of pork than others, some breeds are distinguished for rapid growth and early maturity, producing ripe pork from a carcass of medium weight, with light shrinkage from gross to net weight. Some breeds are hardier and have better constitution than others. Some have the maternal instinct and milk-giving function singularly well developed, and so on throughout the characteristics which distinguish breeds and individuals.

Experience has shown that by intelligent selection, by line breeding, and sometimes by close breeding, excellent qualities may be intensified and fixed, and that by cross breeding characteristics and qualities may be transmitted or eliminated, and still others modified, and that if cross breeding be intelligently and skillfully practiced, new and desirable characteristics may

be made to appear, and that the result of such skillful practice of selection and cross breeding is commonly manifested in increased vigor.

Experience has also shown that swine of the same breed as well as of different breeds produce a different quality and quantity of pork when fed the same kind and quantity of food, if fed by different methods, as when fed cooked or uncooked, sweet or sour, hot or cold, unmixed or with mixed food, etc.

For the purpose of studying the individuality of breeds as bred in line or as manifested in cross breeding, and for comparing the value and adaptability of each to the conditions of food and climate found here, in short to try to discover which is the best, or to try to produce a better hog for Minnesota than we now have, and to find out the best way to feed swine for profit, and to produce the best quality of pork and with the least hazard and loss, and to try to solve other like problems; I have begun experiments in breeding and feeding. These experiments require much time and patient labor to bring them to satisfactory completion, but the importance of the work demands the expenditure of the time, and the increase in the value of the stock will probably cover the cost of the experiment.

FEEDING SWINE FOR PROFIT.

For the purpose of demonstrating that swine growing and feeding may be made a profitable branch of husbandry in Minnesota I determined to raise and feed a car load of hogs for profit.

The sows were coarse Duroc Jersey bred to a Duroc Jersey boar—just a fair lot of sows. The sows and pigs ran in a pasture lot covered with brush and small oak trees. No grass of any account grew in the lot and the water for swill was pumped. The house in which they slept in winter was not warmer than that which could readily be provided by almost any farmer.

Briefly stated, the results of this trial were as follows:

Seven sows farrowed fifty-five pigs. Estimated value of each sow in pig was \$15. Average time of farrowing, April 15th, 1889. Fifty-four of the fifty-five pigs were raised and marketed.

Total cost of screenings meal fed.	\$ 58.26	
Market value of corn raised and fed.....	154.00	
Market value of small potatoes raised and fed.....	6.25	
Market value of corn purchased.....	61.89	
		\$280.40
Wages for one man at \$30 per month, one hour each day for twelve months caring for sows and pigs.....		36.00

Total expense.....		\$316.40
Fifty-four hogs weighing, March 14th, 1890, (eleven months old), 15,820 pounds, sold at 4 cents per pound.....		\$632.80
Net profit on seven sows above the market value of the food bought and raised on the farm.....		316.40
This is an average net profit on each sow of.....		45.20

In this statement no allowance has been made for depreciation in the value of breeding stock, or for interest on the capital invested. It may be further stated, however, that I fattened five of the seven sows with the fifty-four pigs, and the cost of their feed and care is also included in the gross amount charged to the pigs, and I sold the five sows for \$77.02, or \$2.02 more than the original cost. The other two sows I bred, and Dec. 1st, 1889, they farrowed fifteen pigs, and I have raised fourteen of them, which April 15th, 1890, at four and one-half months old, weighed 1,840 pounds, which at four cents per pound were well worth \$73.60, and the two sows have each farrowed two litters of valuable pigs.

This experiment in feeding for profit would have shown still more favorable results if the pigs had been of finer quality and if they had had a mixture of the blood of some of the breeds possessing the characteristic of early maturity, so that they would have been ripe and finished and ready for slaughter when they had reached an average weight of 225 pounds, and if all the sows bred had been as suitable to breed again as were the two above mentioned.

EXPERIMENTAL SHEEP FEEDING.

But little is definitely known as to what is the cost of making a hundred pounds of mutton in Minnesota, where different kinds of food are used, or just what ten pounds of fat may be expected to add to the selling price of a carcass at a given purchasing and selling value. The effect of different kinds of food upon the grain and flavor of the meat is also one of the features of a sheep feeding experiment.

I have begun an experiment in feeding sixty head of stock wethers and thirty head of wether lambs. The sheep will be fed in different groups, upon different kinds of grain, hay, ensilage and roots, and at the end of the feeding period I pro-

pose having the sheep slaughtered and placed on the market at different times, and obtain the judgment of those of experience as to the quality, grain and flavor of the meat when cooked for food. The scales will furnish a solution of the other questions involved.

Nothing more than an outline of the work is attempted in this report. The methods practiced and the results arrived at in the different experiments have been given or will be given in the bulletins, in extenso.

Upon the station staff has devolved the work of instruction in the agricultural branches taught in the School of Agriculture. The classes in breeding, feeding, dairying and practical creamery work, in grasses and fertilizers, in botany and horticulture, in zoology and chemistry, &c., have been taught by the members of the station staff. This service has necessitated a large amount of labor and has occupied a large share of our time during the fall and winter months. The value of this work and the estimate placed upon it by the citizens of the state is already apparent, and the interest and enthusiasm manifested by the students in those branches of agricultural study and investigation upon which their time has been thus far employed, furnishes proof that the students fully appreciate the value of instruction in practical agriculture, and that they will put into practice that which they have been taught.

When I began service at this station I was instructed to reduce the incidental operating expenses to the lowest point consistent with efficient service. This I have done. All the men employed in the agricultural division were discharged except two, a teamster and a stockman, and students were substituted instead. No men, other than the two mentioned, were employed. No carpenters or skilled laborers or mechanics of any kind were employed for any purpose, in doing the building, remodeling and repairing of the buildings, removing and resetting boiler and engine and other machinery, repairing pumps or pipes or putting water service in veterinary hospital, in planting, cultivating and harvesting the crops, in rebuilding fences, in making drains, in caring for the stock, in grading the grounds, or for doing any service of any kind until the time for cutting ensilage arrived, and but little additional help was employed until the time the students returned to school. The employment of student labor necessitated a great deal of attention to detail and occupied much of my time.

A large share of my time was required also in giving to the committee on agriculture such service as could be rendered by one who was constantly on the ground, and familiar with the details of building, in the work of building and furnishing the new building for the School of Agriculture and the Veterinary Hospital, in digging a new well and furnishing an abundant and permanent water supply for the school, in putting in steam heating and water service, in drainage and grading, and in all the numerous details of such work as has been performed for the committee on agriculture. During the season of 1889 the help at the experiment station consisted in part of students from the farm school and partly of men kept in service during the past winter.

One year ago the mailing list of this station was composed of about four thousand names.

Through the kindness of some of the officers of the agricultural organizations of the state, and by the aid of others to whom I am under special obligation, I have been able within the past year, to increase the mailing list of the station from about four thousand to about twenty thousand.

We are able now to place the bulletins and reports of the station in the hands of nearly twenty thousand English reading farmers, in this state alone. The large and continually increasing number of special requests for the bulletins of the station, indicating as it does, a desire on the part of the farmers for a knowledge of better methods and better practice in the art of agriculture, and as manifesting an appreciation of the work the station is striving to do for the citizens of the state, is gratifying and encouraging.

On Sunday afternoon Oct. 5, 1890 we met with a serious disaster in the burning of the experiment station office building, together with nearly all of its contents. This building, containing the library, laboratory, and offices for the director and accountant, and for the members of the station staff, was completely destroyed, together with the laboratory equipment, a large part of the library and all the station reports, bulletins and records, and much of the memoranda of station work. It is not easy to estimate this loss, which appears greater day by day, as the record of work done and data collected are needed for use and for reference. We hope that the much needed station office building may soon be rebuilt.

Accompanying this is a brief report from each of the members of the station staff, of the main features of the work

undertaken in the different divisions, together with the results obtained. The station bulletins describe in detail the methods employed.

In conclusion, I desire to express my thanks to the Board of Regents for both official and personal assurance of their appreciation of my efforts in their service.

Respectfully submitted,

N. W. McLAIN,
Director.

DIVISION OF AGRICULTURE.

FIELD EXPERIMENTS.

In compliance with request, I herewith hand a short statement of the experimental work in which I have been engaged.

The tests of varieties of corn for yields per acre of grain and of ensilage and for composition and feeding value of silage have been continued. The fire destroyed part of the records of this work, together with nearly all the carefully selected seeds of many varieties adapted to the different parts of the state. That the great want of our farmers in the way of corn is better varieties especially suited to their several localities and needs, is plain. These can be developed here on the station farm and by the farmers themselves by the simple but important process of selection, aided in some cases by cross fertilization, also easily done. In the feeding tests comparing the general classes of corn for silage, cows relished silage made of dent corn grown in hills and silage of southern ensilage corn grown thickly in drills, and much more "watery," nearly equally well. Silage of flint corn grown in hills, as for grain, did not seem to suit their taste so well. The silage of dent corn proved, in this test, to be more economical, ton for ton and acre for acre, than the silage of flint corn. More dry or "water free" substance was required to produce a hundred pounds of milk when silage of southern ensilage corn was fed than when silage of dent corn was fed, and the cows fell off more in their milk when changed to the former than when changed back to the dent corn, with the same rations of grain. While more feed can be grown per acre of the larger "watery" southern corn planted closely in drills, we still believe that most of our farmers should raise for silage the same kinds of corn they raise for grain. In the southern half of the state the largest dent varieties that will nearly or quite ripen are best—possibly sweet varieties are as good; while farther north sweet and flint varieties that will nearly or quite ripen are recommended. The testimony of experience places the age for cutting, these kinds of corn for silage at the time when the grains are hardening at the outer ends. Our corn silage certainly proves to be a very economical part of our practical rations in these carefully conducted feeding trials.

That our farmers usually cultivate their corn too deeply has been further demonstrated. (See Bulletin No. 11, and those to follow.) In 1889, under rather drouthy conditions in a field cultivated shallow, pruning the roots with a knife run six inches away from the hills and six inches deep, the yield of grain was reduced thirteen bushels per acre and the yield of fodder one-fourth ton per acre. In 1890, under conditions of ample moisture the same treatment reduced the yield only about two bushels, while the fodder was reduced the same as in 1889. Deep-going cultivators may not always reduce the yield, but root pruning probably never does any good, and sometimes does very great harm. Cultivators with several shovels on either side seem to be the most practical type while those

which work on the same plan as the Acme harrow also did excellent service in our trials of cultivators. During the past season but little effect was produced by destroying the above ground roots or "brace roots" of corn, thus preventing their entering the soil where they would assist in holding the plant erect and in furnishing the plant with food.

FIELD PEAS AND OATS.

On land not very weedy sowing field peas in drills far enough apart to be cultivated did not pay as compared with sowing in close drills or sowing broadcast. During this moist year two bushels of peas per acre seemed abundant. More are needed on dryer lands, say two and a half bushels. On moist land seeding one half bushel of oats per acre gave so many plants to spread by tillering that they almost smothered out the peas from two and one half bushels of seed. On such land sowing these crops together will not always pay. The oats should be in the proportion of ten to twenty quarts of seed to two bushels of Canada field peas, the dryer the soil the greater proportion of oats.

Bulletin No. 12 gives the main results of our study of grasses to date. All the more practical of these grasses are being constantly experimented with and a quantity of Russian pasture and meadow grasses and clovers being imported for trial in our climate. Timothy, red clover, red top grass, Alsike clover, and Kentucky blue grass are now our most useful kinds for meadows and pastures. Corn and the millets are not nearly as well appreciated for forage by our farmers as they should be. Temporary pastures and meadows to stand a few to several years succeed in all parts of the state, and the first four named grasses and clovers are best. Only the two grasses named succeed in some new localities but clover is gradually going westward with immigration though not keeping quite up with the van. Permanent meadows in all our dryer sections rarely pay with the grasses and clover we now have except in wet lands where red top can be used to supplant the wild slough grasses and sedges. Permanent pastures pay only on lands that cannot be readily used in the more productive short rotations. Kentucky blue grass on tillable lands and red top on wet lands are best for permanent pastures, or mixture of these two may do well. As these do not make good crops until they have a few years in which to form sods, timothy and red clover may be sown with the former and timothy and Alsike clover with the red top on moist lands. These make pasturage while the permanent grasses are getting well established. Several ways have been tried for economically seeding alfalfa but without success. None of our useful native grasses, so far as studied, can be economically seeded as seeds are not easily obtained. Improvement of timothy, clover, and wheat by selection and cross fertilization has been started.

EXPERIMENTS WITH FERTILIZERS.

In connection with Prof. Harper, I undertook the testing of some of our so-called worn out wheat lands, with the several different classes of commercial fertilizers. Forty plots were laid out on the March and Spaulding farm, at Warren, Marshall county, in the Red River Valley. The same number on S. Huntington's farm at Windom, in the south-west part of the state, and also on the Chamberlain farm at Taopi, in the

southern part of the state. Nitrate of soda, muriate of potash, and superphosphate of lime (plain), were used singly and in combination; also lime, land plaster, salt and one or two kinds of mixed fertilizers were used at each place. The lands chosen had been under the "wheat farming" system for ten to twenty years. The results show that these lands are still very rich, and that we cannot yet afford to purchase many commercial fertilizers. The records of results at Taopi were all lost in the fire, as were also a small part of those at Warren and Windom. At Windom the land plaster and "complete fertilizer" made an apparent increase of five to fifteen bushels of barley per acre over plots not treated. Tankage, salt, lime and superphosphate made a slightly increased yield, while the nitrate of soda and muriate of potash showed no beneficial results. On flax superphosphate here produced two to five bushels more, while no other fertilizer caused an increase of over two bushels per acre. At Warren no fertilizer caused greater increase of wheat than about two bushels per acre, while the average of all was the same as on plots not fertilized. Superphosphate made an apparent gain of five to seven bushels of oats, while the mixed or complete fertilizer made an apparent gain of three to five bushels per acre. Other fertilizers made little gain of oats. As a matter of memory, simply, I record that plaster, phosphates and mixed manures made an increase of yield at Taopi. The nitrogen also produced here a considerably greater growth of straw. The land at this place had been more worn than at other places. Wheat is no longer depended upon in Mower county. The fact that no fertilizer brought back the old-time yield of wheat illustrates that our wheat has failed, not from a lack of richness in the soils, but on account of rust or other diseased condition. The man who finds a practical remedy for "rust" of our cereals will be worthy of greatest reward.

Respectfully submitted,

W. M. HAYS.

DIVISION OF ENTOMOLOGY.

In Bulletin No. 4, issued October, 1888, was given a full account of the various parasitic low plants which kill insects, and especially of those that are fatal to our two most injurious insect pests, viz.: the chinch-bug and the locust or grasshopper. It was there stated that the chinch-bug disease was spread artificially along the line of the Minnesota division of the C., M. & St. P. R. R., from La Crosse to Pipestone, and from Red Wing to La Crosse. The results of the introduction of this fatal disease were most gratifying, but they seemed at that time to be too great to be simply accounted for by an introduction of the disease alone. During 1889 a personal investigation through a great part of that region, and a considerable correspondence with farmers residing there, as well as the answers received in reply to 5,000 circulars, have, however, given convincing proofs that the disappearance of the chinch-bugs was really due to this disease, and owing to it almost no losses have been reported from the same region for the last two years as having been caused by this pest. The atmospheric conditions being greatly in favor of the disease when introduced, it spread with wonderful rapidity over nearly one-fifth of the state, but stopped as suddenly when these conditions were no longer suitable to its increase. This is the first time that a disease was utilized to kill injurious insects. Experiments have to be made to enable us to retain and confine germs of this and similar diseases, so that, if favorable atmospheric conditions prevail, they may again be utilized to destroy our worst enemies. To this end a properly equipped laboratory is absolutely necessary, as with the facilities and instruments now at hand careful and successful work is impossible. A saving of at least \$15,000,000 by such a simple means indicates plainly that the state could well afford to spend some money in this direction.

The chief work done by the entomologist in 1889 was to continue the fight against the Rocky mountain locusts, which were scattered over about one hundred square miles in Otter Tail county. The past legislature having wisely created a fund of \$20,000 for this purpose, work could commence early and could be continued cheaply and successfully. His Excellency Governor W. R. Merriam, with the permission of the Board of Regents, appointed the entomologist to carry out the necessary operations. He was diligently assisted by Capt. O. C. Chase, the intelligent chairman of the county commissioners of Otter Tail county. A full account of this work was given in Bulletin No. 8. This bulletin contains the results of an early inspection, describes and illustrates the area in which eggs of locusts were found, the condition of the eggs, describes and illustrates minutely how eggs of locusts are laid and why nearly all the operations carried out were based upon the possible prevention of the hatching of these eggs, describes the earlier experiments made with such eggs with the view of preventing the young locusts from reaching the surface of the earth, describes the means actually employed in 1889 to kill

the locusts by plowing, burning, by catching with hopper-dozers, by rolling and with poison, discusses some needed legislation, gives the expenses of exterminating the locusts in 1889, (only a little more than one-half of the money appropriated was expended), describes the investigations of the plowed fields in July, after the work had ceased, describes and illustrates parasitic and carnivorous insects assisting in the work, and finally gives illustrations of some other native locusts liable to be mistaken for the Rocky mountain species.

During the summer of 1889 it became very evident that the invasion of these injurious insects had come forcibly to an end, yet the very natural fears of fresh danger remained in the minds of some that swarms of these insects might have escaped detection, and would breed again in 1890. Careful inquiries during the last year have shown that no members of the invasion survived, and that in fact no Rocky Mountain locusts could be detected. The work performed in Otter Tail county shows that a local invasion can be successfully combated if the necessary means can be employed in time.

But the danger of fresh invasion remains, and it is in the line of wise legislation to take time by the forelock, and provide the necessary means for suppressing another outbreak. The Rocky Mountain locusts are becoming very numerous in their native breeding places, and have already produced some swarms extending beyond their usual haunts. In fact a large swarm of locusts passed on August 14, 1890, over Crookston, flying in a southwesterly direction. It is true the few mutilated specimens received by the entomologist indicated three native species, but this material was insufficient to furnish proof that the "hateful grasshopper" was not a member of this swarm. Through the kindness of the St. P., M. & M. R. R., the entomologist was enabled to inquire into this matter, and found that this swarm had continued its flight from Crookston over Fosston, and had landed near to and in the upper Rice lake in the White Earth Indian reservation, where the great majority of the insects composing this swarm perished. Some eggs were deposited near Crookston, and especial attention should be paid to the locusts resulting from them; but it could not be learned that others had been laid elsewhere. It will be very wise to recollect that the number of locusts in their home have reached the danger mark, and may, if favored by a suitable season, become not simply a menace but a reality.

The life, history and habits of a new and very destructive cankerworm was nearly completed in the region near Perham, and remedies against it will be tried as soon as an opportunity offers.

During the summer of 1889 the numerous species of insects injurious to willows, poplars and other trees planted for wind-breaks, were studied, and the results were described and illustrated in Bulletin No. 9, issued in September, 1889. Illustrated life-histories, accounts of parasites, and methods of combating the following species were given: The Large Willow Saw-fly, our most injurious insect to trees composing wind-breaks; the yellow-spotted Willow-slug, the streaked Cottonwood Leaf-beetle and allied species, the Poplar Borers and Girdlers, the *Antiopa* butterfly, the Fall Web-worm, the Cottonwood Dagger, the *Cecropia* moth, and other insects were described. Illustrations showing a number of machines useful for spraying, and composition of kerosene emulsion were also given.

This work was continued during part of the summer of 1890, and the entomologist succeeded in discovering a new parasite infesting the most injurious of the above insects. A number of them were introduced in badly infested wind-breaks composed of willows and poplars, where they had not been found before, and others will be introduced elsewhere, or as soon as they can be obtained in sufficiently large quantities. A very large number of different kinds of insects not described in Bulletin No. 9, were studied and experimented with, but as the work is not quite finished the results will not be published until later.

The leaf-lice infesting cabbage being very numerous and injurious, a parasite killing this pest was successfully introduced, and the host of lice were more than decimated in consequence.

Early in 1890 a part of the studies of such insects which were injuring or killing oak trees in the wooded portions of the state was finished, and the results were published in Bulletin No. 10, issued March, 1890. The life-histories of the most injurious species of insects belonging to the order of moths, were given and illustrated, as well as the natural and artificial means to combat them successfully; the injurious species of the other orders of insects will be given in a future bulletin. The insect causing the death of black oaks, now assuming proportions that threaten to destroy most of them in some regions, was discovered and remedies were tried. But owing to other work in prairie regions the work was discontinued until the coming spring, when preventive remedies will be tried. All the stages of the life history of the insect causing the trouble have been studied; also that of the insect causing the death of young ash trees in wind-breaks. Insects infesting the apple, plum and grape vine, have been studied whenever an opportunity could be had to have access to orchards.

A large amount of time has been devoted to a collection of Minnesota cut-worms in all their stages, but much work remains to be done before satisfactory results can be obtained. To carry on such investigations rapidly and successfully, the entomologist should be encouraged by the various railroad companies with transportation, to enable him to visit infested regions as soon as an occasion arises.

Considerable correspondence was had with farmers in regard to the distribution of chinch-bugs, and a number of questions relating to the area occupied, and the destruction caused by this pest, were mailed in the form of a circular to about 5,000 addresses in this state, and much valuable information concerning the distribution of this pest in Minnesota, has been collected.

Yours respectfully,
OTTO LUGGER.

DIVISION OF BOTANY.

During the winter of 1888-1889, at the request of His Excellency Governor A. R. McGill and with the permission of the Board of Regents, the botanist made a number of trips to the Red River Valley, to investigate the conditions of the wheat crop, and to collect specimens of frosted, frozen and rusted wheat for study and experiment. His observations were published in Bulletin No. 5, issued January, 1889. In the first part of the bulletin the effects of low temperatures upon plant-life were given and illustrated, and it was shown what takes place in the tissues of freezing plants; the difference between frosted and frozen plants was also made plain by illustrations. In the second part a paper describing and illustrating the life-history of rust was given. It was shown in this bulletin that the crop was injured in some regions by rust alone, but in others by both rust and frost, and it would not be wise to use for seeding purposes grains thus injured. Experience gained later in 1889 showed that poor seed would invariably produce poor crops, a fact already known for centuries, and the ignoring of which necessarily would be fatal to the interest of farmers. In his report to the governor the botanist describes the deplorable condition of many farmers who lost all their crops, and that it was the duty of the state to assist the sufferers by furnishing them good seed.

Much of the botanical work done in 1889 was preliminary. At the suggestion of Mr. O. C. Gregg, the energetic superintendent of the Farmers' Institutes, a trip was made to the vicinity of Windom to study a reported disease of flax, which threatened ruin to the flax growing industry of that part of the state. Early in the spring of 1890 the botanist was appointed by His Excellency Governor W. R. Merriam, with the permission of the Board of Regents, to make all necessary experiments, and to find, if possible, a remedy against this disease. A large number of experiments were made in the vicinity of Windom, and the results were embodied in a report to the governor. A detailed description of these experiments will shortly appear in a bulletin. The experiments show that the so-called disease was not caused by the exhaustion of the soil, nor by any specific parasitic organism, but that it could be produced at will by the addition of old flax straw to any soil in which flax was to be grown. They also proved that no direct remedy seems to be possible, but that a proper rotation of crops would be the only method to prevent losses. This bulletin gives also a detailed description of the methods to produce good and fine fibre in the best flax regions, shows the structure of the stem, and the necessary operations to separate the fibre from the other parts of the straw.

Besides the work mentioned above a large amount of detail work incident to the office of entomologist and botanist, such as the formation of a collection of Minnesota insects, and the material for biological collec-

tions, the gradual collection of the history and habits of a great variety of insects injurious to gardens, crops and trees, the breeding of parasitic insects, the study of plant diseases, and the formation of a herbarium of plants of economic value or injurious to our crops, was carried on at the station.

The correspondence of the office is gradually increasing, averaging now about 90 letters per month. Numerous inquiries in regard to noxious insects have been answered, and specimens of insects and plants have to be named almost daily.

During the winter of 1888-1889 lessons in economic entomology were given to the students of the Agricultural School, and in general zoology during the winter of 1889-1890. In the absence of suitable text books, and to illustrate the subjects of the lessons, a large number of colored drawings had to be made in addition to the preparation of the actual specimens.

Yours respectfully,

OTTO LUGGER.

DIVISION OF VETERINARY SCIENCE.

Herewith is presented the first report of the experimental work performed by me in my capacity as veterinarian to the experiment station.

I. During the first days of November, 1889, I received a package from the southern part of the state containing about five pounds of a weed named "Amorpha Canesceus," with the request that I determine whether this weed be poisonous to sheep or not. As the plant is nearly related to "Astragalus Molissimus," which produces the dreaded loco-disease, I thought it worth while to experiment with. But the quantity received was too small to undertake any systematic experiments; I therefore requested the station chemist, D. N. Harper, to make a chemical extract of the weed with the view of testing its physiological action. On November 19, 1889, the director of the experiment station turned over to me two Shropshire rams for this purpose.

The extract of the weed measured about one and one-half ounces, was of a honey-like consistence, of a brownish color, odorless and of astringent test. I mixed it with powdered althaea root into three balls and administered it to one of the rams within three days with corresponding diet.

The animal was carefully watched, but with the exception of a limited dilation of the pupil of the eye, no symptoms of any physical disturbance could be noticed. The temperature remained normal.

In the meantime I observed that the weed in question was growing on a hill near the experiment station. Accordingly I had it collected and fed to both rams as long as it could be found, which was about 14 days. In the beginning the rams did not like this food, but in time, as no other food was given, they commenced to eat and like it, and digested it well. During the time of feeding with *amorpha canesceus* no irregular symptoms whatever could be observed, and as far as this experiment goes the result was entirely negative, *i. e.*, this weed cannot be considered as noxious to sheep.

II. On March 20, 1890, a red cow, Jersey grade, belonging to one Mr. Fletcher, Minneapolis, was brought to the University veterinary hospital for treatment of a tumor of the lower jaw. The owner reported that the tumor had been noticed first about September, 1889, and that it has been slowly but constantly increasing in size. He requested the extirpation of the tumor if possible.

An examination showed the tumor the size of a child's head, extending all along the left angle of the lower jaw from its bifurcation up to the throat. It adhered firmly to the lower jaw, was of a hard consistence and moveable only on its external circumference.

On March 23, 1890, I had the animal secured for operation. In making an incision it was found impossible to remove the tumor to any beneficial extent, as it consisted of an osseous tissue. Accordingly I desisted from

further operation, after having secured several pieces of the tumor for microscopical examination. This was undertaken immediately, and the tumor proved to contain the typical forms of the actinomyces-fungus, forming a tumor called "lump-jaw" or actinomycosis bovis.

I informed the owner that the tumor had been allowed to develop beyond surgical control, and he presented the cow to the hospital for experiments.

My intention was to use the cow for inoculations, but as animals suitable for experiment could not be secured at once, I had to postpone such tests until May 18, 1890, when I inoculated three dogs and two cats. The virus was taken from an incision made into the tumor of the cow about one inch deep. The five animals were inoculated with Gerlach's inoculating-needle in the upper respectively lower jaw on different parts especially between the 1 and 2, and 2 and 3 molar-teeth. One dog died after five weeks from distemper, but the other animals were frequently examined and no new growth could be observed within five months after inoculation. This confirms the statement of some pathologists, that carnivorous animals are not susceptible to successful inoculation with actinomyces bovis.

About the middle of July, 1890, the cow in question dropped a bull-calf; as this calf was of little value, I inoculated it on September 5, 1890, in the presence of Drs. Brimhall and Eddy, of Minneapolis. The inoculation was performed as described above, with the modification that I not only inoculated within the mouth but also introduced the virus externally through the skin of the left lower jaw. On September 27, 1890, when I examined the calf I was much surprised to find a well defined tumor on the place where I inoculated externally. The tumor was then of the size of a pigeon's egg, and readily movable; since then it has been gradually developing and extends now, December 20, 1890, nearly the whole length of the left lower jaw. Although this artificially produced tumor presents all the characteristic points, so easily recognized in lump-jaw, I made an incision in it on December 18, 1890, for a microscopical diagnosis. Not as many actinomyces could be found as in specimens taken from the old tumor of the cow, perhaps only one-tenth of them; still there were enough to make sure a diagnosis of actinomycosis.

As my experiments in this line are only in the commencement, no conclusions will be drawn. It may be mentioned, however, that besides the successful inoculations of Johne and Crookshank and others, this is one of the few cases on record against a large number of unsuccessful inoculations. It is confirmatory of the theory of artificial transmissibility of actinomycosis bovis, and the actinomyces-tumor may even be classified with the infectious tumors as Perls has done; but no reason can be seen, as yet, to obtrude on this tumor a contagious nature, which would be against the sense of the word as applied in the technical language of modern pathology.

OLOF SCHWARTZKOPFF.

REPORT OF THE DIVISION OF HORTICULTURE.

To N. W. McLain, Director of Experiment Station, University of Minnesota:

The work of this division for the past two years has been progressive and of interest to the horticulturists of the state. Some of the lines of work pursued are very promising of valuable results. In planning the work I have had the counsel and help of many members of the State Horticultural Society, to whom my thanks are due.

The correspondence of this division has largely increased during the past year. Inquiries are frequently received in regard to the best forest and fruit trees, and as to methods of planting and culture, and besides, there is a constantly increasing demand for station bulletins, giving the results of experiments made in this division, and asking for information in this line.

With a view to satisfying the popular demand for reliable data regarding the many species and varieties of plants which are annually put upon the market, I have planted such as have been recommended as desirable for this state, and in some instances have procured plants from introducers a year before they were offered in the general market. Introducers have often wished us to try their novelties, that they might profit by our recommendations, and when they have proven of value and an addition to our list of cultivated plants, I have not hesitated to give them commendatory notices. Unscrupulous nurserymen have for many years deceived the public and wheedled them into buying that which has been new and untried, in preference to that which is of known value, until it has become necessary for each novelty in fruit and seed to have the highest endorsements accompanying it. This division of the station has a good work to perform in giving to the citizens of the state the latest attainable information regarding newly introduced varieties and species of economic plants.

The honest nurserymen and seedsmen throughout the country are becoming more and more interested and confirmed in the belief that they should work with the experiment stations, and that their lines of work should supplement and not conflict with each other. In many cases of novelties received for trial, it is customary for the experiment station to bind itself not to distribute the same without permission from the introducers. Such restrictions are no more than common business prudence demands, and have been freely granted.

LANDSCAPE WORK.

During the season of 1890 much of my time has been given to directing the laying out and grading of the grounds adjacent to the farm school buildings and the entrance to the experiment station. It has been my aim to do the work both economically and thoroughly. Aided by several of my colleagues, I have obtained appropriations from the commissioners of Ramsey county and from the St. Paul city council, which have secured

for the university the permanent grading of Cleveland avenue for one block. The doing of such grading by the city and county was a step necessary to be taken before it was practicable to make a good approach to the new farm school building. After some solicitation on the part of the Hon. J. S. Pillsbury, the owners of the block of 40 acres on the south of the main entrance permitted the university to place one-half of the main entrance to the farm, four rods wide, on their land. This enabled us to permanently grade this drive, by which the aspect of the school buildings, as well as the approach to the farm, has been greatly improved. In the permanent grading of Cleveland avenue and the main entrance to the station farm, we have got a basis with reference to which we may carry on all future improvements.

I am very glad that there is a disposition on the part of the board to decide upon a general outline of arrangements for future buildings. Some general plan of procedure is very necessary, and without it our buildings can never present that harmonious appearance so necessary to good general effect. A yearly appropriation should be made to keep up this phase of the work and to maintain the grounds in proper order.

INSTRUCTION AT THE FARM SCHOOL.

During the sessions of the farm school, most of my time is required to properly attend the classes in botany and the various branches included under the very general head of horticulture and forestry. It is my aim to make the instruction in these studies practicable and serviceable, and to avoid empirical rules.

While it is in many important ways an advantage to our students to have their instruction in agricultural studies in the winter, yet teaching these studies at such an unseasonable time makes it very difficult and often impossible for the teacher to convey a just appreciation of the many methods that obtain in practical work.

The greenhouse is a source of much that is of value in instruction. It furnishes material with which to illustrate the work in botany, and besides, represents an industry in which great advancements are made yearly. It is also a valuable aid in propagating plants for the nursery and for experiment work.

The classes appear to be making good progress in the work placed in my hands: I find, however, that in the study of botany which can be illustrated by plants grown in the greenhouse, instruction is usually more satisfactory than in some other studies, (such as fruit culture), in which most of the instruction must be from books or lectures alone, without practical aids. I find the students are desirous of making the most of themselves and their opportunities.

PUBLICATIONS.

Publications of this department during the past two years were as follows:

Bulletin No. 5, containing a report on comparative tests of sixty varieties of cabbage; descriptions and drawings of native plums; new method of potato culture; propagation of Russian willows and poplars from cuttings.

Bulletin No. 6, devoted entirely to a report on the germination of frosted and rusted wheat, with criticisms of the results by practical men.

Bulletin No. 7, gives a report on many varieties of potatoes cultivated on the station land; value of differently constructed walls for buildings, with report on their relative conductive capacity.

Bulletin No. 9, contains our information up to date on the newly introduced Russian willows and poplars.

Bulletin No. 10, has a report of experiments showing the great value of a compact seed bed for onions; experiments with different methods of planting and different varieties of cabbage; on the syringing of plums with London purple to destroy the curculio; on bagging grapes; on Rollingsstone plum; and on planting potatoes at different depths.

Bulletin No. 12. Has a report on American grown cauliflower seed and preserving vegetables in carbonic acid gas.

ARBORETUM.

Some progress has been made in forming an arboretum and some considerable additions have been gained by donations and purchase. We are much indebted to Arnold Arboretum, of Harvard College, Mass., for the donation of seventy-three (73) species of *Pyrus* and *Prunus*, and for kind promises of future help in making our collection a representative one.

Prof. Budd, of Ames, Iowa, also has generously donated at various times seeds, cuttings and plants of much value.

By purchase various trees, shrubs and herbaceous plants have been obtained. The coming year should see much encouragement given to this very important line of work.

FREE DISTRIBUTION OF TREES.

I think that sending out trees and plants by this division of the experiment station has resulted in much good and that annually an appropriation should be made for this special purpose. It is quite impossible, nor is it desirable, for the experiment station to send out anything more than small trial packages of well tried novelties. Many farmers in portions of the state have become discouraged about planting apple trees, because owing to improper selection of varieties or to poor cultivation they have been unsuccessful in the past; it seems to me therefore it would be well to propagate in the nursery some of the most promising hardy apples and other fruit plants for distribution to parties who will care for them properly and report results. A successful growing and fruiting apple tree in any neighborhood is at once a source of inspiration and hope to all who see it, and while it has not been proven that orcharding on a large scale in this state is generally a paying undertaking, it has been most conclusively shown that there is no reason why the farmers of most of the state should not grow the fruit needed for their own use if they will but go to work about it in the proper way.

APPLES.

Probably there is no more promising line of experimentation than that afforded in the attempts made to obtain for our state a variety of apple which shall be as hardy or hardier than the Duchess of Oldenburgh and one that will keep during winter. Besides the obtaining of such a desideratum as this, in the introduction of varieties of greater merit than those now grown, is a field of much promise. During the severe winters culminating with that of 1886-87, the Duchess proved itself

of very superior hardiness, and since then propagators in the northwest have very generally looked to it as the most promising source from whence, by proper care, should emanate seedlings as hardy as itself, but of a different season of ripening. There are now several such seedlings in the field which are very promising. And I wish to call attention to the fact, that the Duchess apple is an early introduced Russian, and it is but a type of a large family of apples which are grown in the cold northeast of Europe. It is very proper then that all the numerous varieties of apples, of Russian origin as well as others, should have a careful trial. It has been a line of work which I have carefully studied, and I am confident that some of these Russian apples will prove of great value, and from seedlings of these it is probable we may obtain varieties much better adapted to our trying conditions. I do not propose to draw conclusions as to the value of these apples from results obtained outside of the state, but only after they have proven their value in this locality.

The data in regard to the apples now on trial on the station lands is so extended that it would not be permissible in a report of this nature, and it will be given in a future bulletin. Of those now on trial that have fruited in this vicinity and are of most promising hardiness, I should mention the Hibernial, Lieby, Christmas, Green Streaked, Good Peasant, Ostroff's Glass and Antonovka.

After due consideration a new orchard site has been selected at the north side of the hill in order to give a more favorable location for those varieties of apples which need dry land for their best development. It is not well known that some varieties of apples thrive in a very moist loam, while others would fail completely in such a location. For instance, the Totofsky comes to us from a low section in Russia and it will stand in moist loam where the Duchess would be a complete failure. This new location is also a more favorable one in every way than the site on which our experiment orchard now grows and will be a valuable supplement to the latter.

PLUMS.

We have now in cultivation twenty-three varieties of plums. Many of these have not yet fruited here, while others have proven a great addition to our list of cultivated fruits. Varieties of our native plums are especially promising and are already grown and being planted by our commercial fruit growers on a large scale. The varieties which have proven most valuable at this station and over a large portion of the state are De Soto, Weaver and Forest Garden. By planting these three varieties the season for fine eating plums may be continued over six weeks.

CHERRIES.

The cultivation of this fruit is full of promise. In parts of Russia a large amount of this fruit of excellent quality is grown in the bush form. Frequently the bushes are not much larger than the currant bush. Heretofore the chief objection to growing them successfully has been that we have had no hardy sort to graft on, but the introduction of the sand cherry as a stock will obviate this difficulty. We have fourteen of the most hardy varieties on trial, but have not cultivated any of them long enough to permit of a report. Last August I received from Riga, Russia, four

and one-half pounds of cherry seed, part of which was distributed to various stations in the state. I think that this may furnish stocks of superior hardiness.

STRAWBERRIES.

We have had many varieties of this most valuable fruit growing on the station lands, but only comparatively few are any addition to the approved list. As fast as their inferiority is discovered they are weeded out to make room for later varieties. Many kinds are put on the market each year, and some with great éclat, but those heralded with the most noise are not by any means always the most desirable. At present there are a number of varieties competing with the Crescent for first place, but there are as yet none which have been demonstrated to be more valuable over any considerable number of years. It is a pistillate variety and must have some strongly staminate variety near by in order to fruit it successfully. For this purpose the Countess is most excellent and so also is the Wilson. Of the new varieties that have promising I should mention Park Beauty, Bubach No. 5, Warfield No. 2, and Haviland.

RASPBERRIES AND BLACKBERRIES.

The cultivation of these valuable fruits is a pronounced success. While a few growers leave their plants exposed during the winter and without protection, yet the best results are obtained by covering with soil each fall. The varieties that have proven most successful thus far are:

Red raspberries—Cuthbert, Marlboro, Turner, Clarke, Hansell.

Yellow raspberries—Caroline.

Black cap raspberries—Nemaha, Ohio.

Purple cap—Schaeffer's Colossal.

Blackberries—Ancient Britton, Early Harvest, Stone's Hardy.

GRAPES.

There are many new grapes that are candidates for favor and several that, on account of their early ripening and good flavor, are very promising novelties for this state. There is quite a general feeling among grape growers living in localities not especially favored by the modifying influence of water, that the Concord is not a profitable grape to plant on account of its ripening its crop so late as to be liable to injury from early frosts. At the same time most of the commercial fruit growers who are in favorable locations cling to it as being by far the most profitable variety to grow. Our vineyard is not favorably located and we find the following varieties to be the most promising: Worden, Moore's Early, Lady, Lindley, Delaware, and Early Victor. The Brighton is one of our best grapes when covered with paper bags early in the season. The Janesville is the first grape to color but can hardly be classed among dessert grapes. Its chief use must continue to be for culinary purposes, although where no other grapes can be grown it is used for dessert purposes.

I hope to issue a special bulletin on small fruits the coming season.

NATIVE FRUITS.

We are experimenting with a view to improving the most promising native fruits, such as the Juneberry, (*Amelanchier oblongifolia*) and

cherry, (*Prunus pumila*) and blueberry, (*Vaccinium corymbosum*.) Some varieties of each of these plants are very promising of future usefulness, under cultivation. The sand cherry is already in some parts of Dakota looked upon as a valuable fruit and bears very heavily in rich prairie land, while such plants as fruit heavily here are in the poorer soils, and have not proven of much value when cultivated in rich soil.

Of the blueberry we have some very promising seedlings from plants that have fruited heavily under cultivation. The Juneberry fruits abundantly but the birds are so fond of the berries that but few remain to ripen unless the plants are protected by mosquito netting.

FORESTRY.

I consider the subject of the introduction of better kinds of forest trees, methods of management and culture as lines worthy of the most continuous attention.

With a view of furnishing some exact data as to the comparative growth of different trees and their value for economic purposes, a plantation of some 2½ acres in extent containing all our native deciduous and evergreen trees as well as many from Russia and other foreign countries has been planted the past season. Besides serving as an experiment this plantation will be of much service in our course of instruction in this line in the farm school.

Several experiments bearing on the production of coniferous plants from seed have been successfully prosecuted the past season, the results of which will be published in a bulletin shortly to be issued.

VEGETABLES.

Numerous trials of varieties and methods of cultivating vegetables have been carried on during the past two years, many of the results from which have been published in various bulletins while others are to be issued shortly.

SEEDLINGS.

The work of originating fruit plants better than those we now have, I have taken especial interest in, and have many seedlings of various fruits in our nursery. I think this an important step, since many fruits which are adapted to other states are not fit for this on account of its trying climate. In fact, as I have often repeated, Minnesota must have her own system of horticulture, and it must be originated on her own soil, and the planting of seedlings is one of the steps by which we shall get improved varieties.

OTHER EXPERIMENTS.

Numerous experiments of minor importance have been made, of which the following heads will give some information:

1. Experiments to ascertain the most favorable season and method for grafting grapes.
2. Experiments in summer propagation of roses and other hardy plants.
3. Experiments in propagating by grafting the *Salix Napoleonis*.
4. Experiments in propagating coniferous evergreen trees from seed.
5. Experiments with the use of tankage from South St. Paul Stock Yards.
6. Experiments in germinating seeds.

Respectfully submitted,

SAMUEL B. GREEN.

REPORT OF AGRICULTURAL CHEMIST.

N. W. McLain, Director Experiment Station, University of Minnesota:

DEAR SIR: In compliance with your request of the 15th inst., the following report of the work of this division for the years 1889 and 1890, is submitted. January 23d, 1890, a report was handed you of the work for the year 1889, comprising analyses of 608 substances. During the year 1890, 600 additional analyses have been made of milk, wheat, sugar-beets, etc. Some of the general results follow.

WHEAT.

In 1888 the wheat crop of the Red River valley was injuriously affected by rust and frost. Samples submitted were analyzed, and the results in detail appear in Bulletin No. 7. Much wheat was shown to be unfit for seed. Nevertheless, a great deal of such seed was planted in 1889. To collect samples of the seed and crop, study the conditions and observe the results, several trips were made throughout the region affected, transportation being kindly furnished by the Great Northern Railway. A detailed report of this investigation was handed you in January, 1890, and published in June. A condensed statement of conditions, results and conclusions, with analyses of typical samples was, at his request, transmitted to his excellency, Governor Merriam, on January 27th. This report, promptly published and widely distributed, awakened general interest in the matter of wheat cultivation. Samples of the wheat cited in the report were sent in sealed bottles, to all the newspapers in the region affected. The newspapers mentioned this fact, and those interested had opportunity to examine the samples and make comparisons. To prevent a repetition of the results of 1889, Superintendent Gregg detailed Dr. Currier, assistant superintendent of State Farmers' Institutes, to take charge of special wheat institutes held at five principal points in that part of the Red River valley most affected. Prof. Hays, Richard Waugh, myself, and the farmers interested, participated in the proceedings. The institute at each place was well attended and very interesting. All farmers had been specially requested to bring small samples of their seed wheat, and examination was made of as many of these as possible, and a verbal report given. The number submitted, however, was so great that seven or eight bushels of wheat, in small packages, were brought back to the station for examination. A general summary of the principal points developed at these meetings was prepared by Prof. Hays and myself, and sent to all newspapers, with a report of seed wheat examination, and a list of persons and places having good seed wheat. As a result, great care was exercised in the selection of good wheat for seed, and the large crop of this year shows some of the satisfactory results of our work.

NEW VARIETIES.

It seemed likely that new varieties of wheat might profitably be introduced so that I secured samples from such foreign countries as have conditions of soil and climate similar to our own. These have been planted to show, (a) their adaptability to our conditions, (b) the effect of the change, (c) and their value in comparison with our own varieties. The results show that some Russian varieties are equal to our own, but no foreign wheats are superior. About one hundred acres of Ladoga wheat were raised in various places from seed imported from Manitoba. The experiment has been conducted on a sufficiently large scale, over a wide area, under diverse conditions and, so far as I know, the results show that Ladoga wheat is *positively bad*. It is a long berried wheat which shrinks upon maturing. It is a bearded wheat, grows with a spindling stalk, shells badly on ripening, rusts more easily than native varieties and is very smutty. Many experiments in growing it alongside of Fife show that it matured about three or five days the earlier. But the difference is more apparent than real.

COMPARATIVE MILLING TESTS.

Twenty-three samples of wheat, representing the different varieties and grades were milled and the flours compared. The results show that the best Scotch Fife yields the most flour and this makes a dough of the lightest color and greatest strength. The best Blue Stem equals Scotch Fife in yield of flour and strength but the color is not so good. No. 1 Northern wheat may be composed of (1) pure Blue Stem, (2) Blue Stem and hard Fife mixed, (3) pure starchy Fife or (4) a mixture of all. The yield of flour is greatest in 3, the strength is least and the color lightest. 1 and 2 give large yields of flour having the greatest strength but the color is dark. The typical wheat for milling is that which most nearly approaches a sphere in shape, has the lightest color, is most nearly transparent and has the smoothest hull.

CLEANING WHEAT FOR SEED.

Some No. 1 Northern wheat representing an average of the good wheat raised in 1889 was given the ordinary elevator cleaning to remove weed seeds. It then weighed 61 pounds to the measured bushel. A part of this was several times run through a Barnard & Lee machine where a strong blast of wind separated it into two parts. Each was made as free as possible from weed seeds. The one part weighed 55 pounds per bushel and contained the shrunken grains; the other weighed 63 pounds per bushel and contained the plump, dense grains. Equal sized contiguous plots of each of the three different lots were planted with the same amount of seed at different places in the valley.

Results. The crop from the heaviest wheat grew free of weeds and was most uniform in size of stalks and heads. It ripened uniformly and at least a week earlier than the 61 pound wheat and over 10 days earlier than the 55 pound wheat. The 63 pound wheat—the heaviest—yielded the most wheat and of the best quality.

Conclusions.—The wheat best adapted to our conditions is Scotch Fife, of which there are several varieties, such as Wellman's, etc. Some varieties of Blue Stem, particularly that of L. H. Haynes, of Fargo, are of nearly equal value. Improvement on our wheat is most probably to be secured by a careful selection from native varieties. The earliest ripening wheat, having the strongest, brightest straw, should be selected for seed. This should be run through a fanning mill, and the heaviest of all planted. Many farmers have not the necessary opportunities for the proper selection of wheat for seed, and some such means as those employed by me this spring could profitably be practiced annually.

SUGAR BEETS.

In 1889 seed of ten varieties of sugar beets was planted by Prof. Hays on land which it was afterwards found was not well adapted to raising sugar beets. Analysis made showed a reasonably large amount of sugar but low purity.

May 28th, 1890, Prof. Hays planted seed of thirteen varieties on land well drained, of average fertility, but on which no manure had ever been placed. The beets grew unevenly and ripened by September 26th. Average samples of each variety were analyzed; the general average for all varieties being 12.7 per cent. of sugar and a purity of juice of 80.25 per cent. "Simeon LeGrande's White Improved" contained the most sugar, 14.83 per cent.; "Bulteau Desprez's Richest" contained the purest juice, being 87.89 per cent. sugar. Many samples have been received and analyzed from Anoka, Hastings, Red Wing, New Ulm, Hutchinson, Hampden, Le Sueur, Fond-du-Lac, Luverne, etc. These have shown large amounts of sugar, with reasonable purity.

The past season was particularly unfavorable in this locality for the production of a sugar crop of high purity, yet the results show that there exists a large area in the state favorable to the production of a rich sugar beet.

It is probable that we shall find it safe to engage in the manufacture of sugar from beets, but there are few localities in the state where sufficient knowledge has as yet been obtained to show whether the agricultural conditions are favorable.

SORGHUM.

Experiments with Varieties at the Station.—In 1889 twenty-four varieties of cane were planted by Prof. Hays. The season was unfavorable and no canes matured, but analyses were made of canes nearest ripe in each plot. In 1890 the earliest of the above mentioned varieties and several others were planted. None ripened, and no analyses were made. Both seasons have been unfavorable to the production of a sugar crop, but the results seem to indicate that the conditions at the farm are not favorable to the production of sorghum.

Manufacturing Experiments. In 1889, at Cannon Falls, and in 1890, at Red Wing, experiments were conducted on the manufacture of sorghum into syrup. Analyses were made of the juice before and after defecating, when one-half and three-fourths through the evaporator, and of the finished syrup. The results show that cane containing a large amount of sugar with high purity is grown at these places; that the manufacture into syrup is conducted with success and that the industry can profitably

be largely increased. The cane is as a rule not properly cared for. Where it is well cultivated and raised in sufficient quantity, good syrup can be produced at a total cost about one-half less than the local cost of imported syrup. To raise good cane select seed from canes which have ripened early and grew free from suckers, plant on old land having good drainage and an exposed position that has the sun as much of the day as possible. Cultivate well and often, keeping down the suckers. Let the cane ripen, but if caught by frost before maturing strip and cut it, tie up in small bundles and pack in loose piles in a well ventilated place where there is shelter from the weather and sun. Have it manufactured as early as possible.

Field Experiments. Plots of Early Orange, Folger's Early, Kinney's Early Amber, and Early Amber were cultivated by Mr. Porter at Red Wing. Kinney's Early Amber ripened about Sept. 18th, and none of the others were ripe on the 26th, when frost occurred. The Early Amber needed but a few days of favorable weather in which to mature. Analyses were made almost daily from Sept. 16th to Oct. 10th, and showed that the cane previous to frost contained a large amount of sugar with high purity of the juice. The immediate effects of frost, except to prevent the cane from maturing, were not harmful, and even as late as 15 days after the first frost, cane left standing in the field showed no appreciable increase in the amounts of reducing sugars and acidity.

The legitimate field of the sorghum industry with us is in the manufacture of syrup, and probably in the cultivation of early ripening cane of high purity for the production of seed to be marketed in states further south. But more care must be given to the cultivation of the cane.

MILK.

Numerous samples of milk handed in by yourself and Prof. Hays have been analysed and reports promptly returned. Other samples were analysed for the gentlemen having in charge the dairy contest at the state fair. Analyses previously made showed that cows kept under strange and exciting conditions may not give their normal milk. The variation may be great and quite unaccountable. The results might therefore give altogether erroneous conclusions as to the best butter-producing cow. They would show what cow possessed the most tranquil temperament.

While away at Red Wing fire destroyed the station building, the laboratory and apparatus. Before leaving the gas was shut off from the laboratory and no substances capable of spontaneous combustion were kept in that portion of the building where fire originated. A new building is now under way in which ample accommodations are made for the analytical work of the station and instruction for the students in the school. The water supply has always been faulty, and to correct this as much as is now possible a small force pump will be operated in the basement, making the supply constant under uniform pressure, and capable of more economical use.

D. N. HARPER.

REPORT OF E. H. S. DART,

SUPERINTENDENT OF THE OWATONNA EXPERIMENTAL TREE STATION.

To the Board of Regents of the State University and the Minnesota State Horticultural Society:

GENTLEMEN:—All is quiet on the Potomac, is what we used to hear when our armies were manouvering and anxiously waiting to meet our nation's insidious foe. And we may say all is quiet on the Owatonna Tree Station while we are working and waiting for the onslaught of our insidious foe, the elements. We court a moderate degree of early disaster that our works may be tested and strengthened, so as to avert future calamities.

Much substantial work has been done during the last season, the details of which will be omitted except so far as may seem necessary to enable you to judge of its character.

It has been my belief that good results would be obtained much sooner by gathering in the first fruits of other men's labor than by depending entirely upon my own. I have also anticipated grand results from planting the seeds of our most valuable acclimated varieties.

These two lines will be pushed in the future as in the past. In regard to forest and ornamental trees we have thought it best to test all varieties represented hardy at Bloomington, Ill., and some other imported varieties of which little is known as to adaptation. This will certainly bring a great many failures and implies a very long black list. Most men and some states are sensitive about admitting a great preponderance of failures. When the name of magnolia is read on the black list some may say any fool ought to know better than try to grow the magnolia in Minnesota. But how do we know that magnolia acummata, the hardiest among them will not thrive here under favorable conditions? How do we know that dwarf peaches, pears, cherries and apricots may not be profitably grown by covering in winter? If planted on a hill side they could be trained near the ground which would greatly facilitate covering. A hint from you as to the width of the field that I should try to cover or in regard to any other matter will be thankfully received.

As a rule all trees have done well in the nursery. But very little blight appeared and was confined to half a dozen varieties of Russian apples and a few seedling crabs.

INSECTS.

As a protection against drouth the ground was heavily manured. Among nursery rows it could not be plowed under and cut worms became very numerous and destroyed nearly all of the season's planting of seeds and some that were grown the previous season. I tried hard to save the pedigree seeds by hunting out and crushing the worms. But they hid

while I worked and worked while I slept and came out ahead. Under a bunch of green branches carelessly thrown down covering less than a square foot 90 cut worms were counted. Such branches were immediately placed along the seed rows and many worms were destroyed and I have reasons to think that had this plan been resorted to at first, most of the damage might have been prevented.

A WILLOW WORM

appeared later in the season. It was black, about an inch in length when full grown and had 10 yellow spots on each side. It took the leaves clean as far as it went but was quickly destroyed by an application of paris green mixed with land plaster for potatoe bugs.

THE VINE SPHINX

became numerous on Virginia creeper but yielded to the potatoe bug mixture.

FOUR THOUSAND ROOT GRAFTS

were planted last spring comprising 190 varieties of which 56 were Russian and the remainder seedlings, some of which originated on the ground, others being contributions from propagators of Minnesota and adjoining states. An average stand and fair growth has been secured. The ground was kept clean till August 10th when oats were sown for winter protection and covered the ground completely, at the approach of winter. Piece roots 4 inches long were used, have tried long scions on two inch roots but did not get a good stand. Have tried all crown or top pieces of root by the side of all second cuts with no perceptible difference. Many believe that the stock exerts a powerful influence over the scion. My experience is the other way. Give me the right scion and I care little for the stock, provided it is hardy and furnishes plenty of moisture. Will set about 150 varieties of apples and crabs next spring, 20 varieties of Russians, of the remainder many will be new from noted originators.

NURSERY STAKES.

50 stakes have been painted with wax, 300 have been soaked in a solution of sulphate of copper and a few in lime water, to test durability. Iron stakes made of No. 4 wire will be tried in the spring. 1,650 evergreen trees were planted as follows: 500 Scotch pine, 500 Norway spruce, 500 white spruce, 100 red pine, 50 pieca corncolor. Fully 95 per cent. are alive.

THE ORCHARD

now contains 400 trees, 55 of Russian varieties, 20 of seedlings and crabs, 12 of plums, 3 of pears and one of cherries. At least 120 trees will be added each year, and in these additions seedling varieties will predominate.

Trees are 15 feet apart east and west and 10 feet apart north and south. Every 11th row running east and west being of evergreen trees.

I regard 16 feet each way as a suitable distance for such trees as Duchess, while Transcendent crab, if it does not blight, will crowd in 20 years at 20 feet each way.

One object in close planting here, has been to test a large number of varieties without covering too much space. Boards six inches wide have

been placed on the southwest side of more than 100 orchard trees to prevent sun scald. 125 shade and ornamental trees were planted about the school grounds last spring; and though most of them are alive, yet I regret to say, that the situation is much exposed to sweeping winds, and the growth of trees has not been satisfactory. A strong wind break on the south and west is greatly needed.

Fall planting will be tried. Several varieties were transplanted last fall for that purpose.

The Alpine bearberry of the heath family, from Wisconsin woods, may have real merits as an ornamental shrub. It bore shining black berries, size of blue berries, the second year, in great profusion. The fruit, as the name indicates, is good for the bears; but good for nothing else, unless it may have medicinal properties or do for the ugly sparrows when they become numerous.

I have met with frequent failures in growing trees from seed, and I attribute it largely to the want of sufficient moisture in the ground, at and soon after the time of germination. I have left a portion of this year's appropriations unexpended, and will add enough from that of next year, to dig a well or obtain water by piping from the deep well of the state public school.

I append a list of trees and shrubs that are or have been growing on the grounds, and I regret exceedingly that owing to the short time since the work began, and the mild winters that have since succeeded, I am unable in most cases to even indicate merits or demerits. Of marks used 1 denotes best, 2-2d best, 3-3d, 0. dead, B is blight, and X believed to be unworthy of cultivation here. Seedlings of unknown parentage originating here will be designated by letters and letter combinations.

I am under great obligations to the members of our society, and to horticulturists generally, for kindness and material assistance in the work I am trying to do.

LIST OF APPLES AND CRABS.

Autumn Streaked,	Beeches Sweet, C
Acker's Dutchess, Phoenix,	Buschbon,
Anisette,	Browery,
Antonovka,	Borovinka,
Anisouka,	Broad Cheek,
Arcade,	Barr's Yellow Siberian,
Anesim,	Barr's Yellow Hybrid,
Alabaster,	Barr's Hybrid Winter,
Aut St. Russet,	Berry Crab, (Brand)
Arnold's Winter, C	Baldwin Seedling, (Fuller)
Annis Amova,	Butternut,
Aport Orient,	Berry Apple,
Arabian,	X Conical Crab,
Arabian Seedling,	Champaign Pippin,
August, from Bardwell & Haveland,	Cinnamon,
Aport Rosa,	Cross,
Aport Rother,	Cardinal,
Basil the Great,	Cinnamon Pine,
Breskovka,	Cut Wine, seedling from,
Bode,	Charlamoff, seedling from,
Blushed Colville,	1 Duchess, Oldenburg,
Brier's Sweet, C	Duchawoe,
Blushing Maid, C	Duchess Seedlings,

- Station 6 varieties,
 Duchess Seedling 49, (Phoenix)
- 1 Dartt's Hybrid, seedling Tetofsky
 Dartt's Porch, seedling,
 Duchess Seedling, (Patton)
 Disbro's Sweet, (Peffer)
 Drake No. 1,
- 2 Early Strawberry, C
 Enormous,
 Excelsiour,
 Estelline, (Brad)
 Early Harvest, on yellow crab
 (Peffer)
- Foranic,
 Florence,
 German Calville,
 Great Duke,
 Getman's Bean.
 Grocco Skalanka,
- B Gaines Swedisher,
 Good Peasant,
 Gen. Greig,
 Grayest,
 Glass Revel,
 German Skrute,
- 1 Greenwood Crab,
 Gideon,
 Gibb Crab Seedling (Peffer)
 Gibb Crab,
 Gideon No. 6,
 Great Duke,
 Garden,
 Green Sweet,
 Green Butskaya,
 Gork Ripka,
- X Gen. Grant Crab,
 Grandmother,
 Hibernial,
 Horen,
 Homestead Crab,
- 2 Histop Crab,
 Hart Seedling,
 Hutchinson Sweet Crab,
 Hybrid Russet, (Patton)
 Hotchkiss Seedling,
 Hislop Seedling, winter, (Dartt)
 Harris Winter,
 Haas,
 Hare Ripka,
 Heidorn,
 Hansome White,
 Hedge Crab (Dartt),
 Isham Winter Crab (Phoenix),
 Juicy Ribbed,
 Juicy Krimtartar,
 Juicy Burr,
 Juicy Streaked,
 Juicy White,
 January (B & H),
 Kustoe,
 Kursks Annis,
 Kimball,
 Klein Seedling (from Harris),
 Lou (B & H),
- Lowland,
 London Pippin,
 Lieby,
 Lubski Reinette,
 Little Hat,
 Leudloff,
- X Lake Winter Crab,
 Laponachoe Nliv,
 Melonen,
- B Moscow,
 Marmalade,
 Martha Crab,
 Maidens Blush C,
 Meneray,
 McMahon,
- 2 Minnesota Crab,
 X Milton Crab,
 Mills Seedling (Fuller),
 Magnet (Peffer),
 Mitchell's Iowa, seedling,
 North Western, greening,
 Noble Red Streak,
 No Name,
 Orel,
 October (B & H),
 Okabena Seedling,
 Nos. 1 & 2,
 Orloff,
- 2 Orange Crab,
 Popoff,
 Pointed White,
 Prolific,
 Pear,
 Peterhoff,
- 2 Peach Apple,
 Patton's Hyb. Russet,
 Peach Apple, seedling from,
 Plicanoff,
 Powers Crab,
 Prof. Goff (P),
 Palmer's Sweet,
 Plumb's Russet,
 Peffer's No. 10, being Gibb Crab,
 seed male,
 Fall Greening,
 Phoenix Seedlings, 10 varieties,
 Peerless Seedlings from,
 Phillips Seedling,
 Nos. 1 & 2,
- 2 Quaker Beauty,
 Red Bark Crab,
 Red Annis,
 Red Cheeked,
 Red Transparent,
 Richland Winter Sweet,
 Russian B,
 Russian 7 X,
 Russian Green,
 Russian No. 488,
 Russian No. 215,
 Russian No. 1280,
 Russian No. 111,
 Russian No. 804,
 Russian No. 492,

Russian No. 224,
 Russian No. 318,
 Russian No. 322,
 Russian No. 330,
 Russian No. 975,
 Russian No. 31-T,
 Russian No. 2-T,
 Russian No. 11-T,
 Russian No. 18-T.,
 Russian No. 8 Vor.,
 Russian No. 6 Vor.,
 Russian No. 50 Vor.,
 Russian No. 64 Vor.,
 Russian No. 9 Vor.,
 Russian No. 89 Vor.,
 Russian No. 41 Vor.,
 Russian No. R.
 Russian No. X.
 Ribbed,
 Rosa Aport,
 Romna,
 Rubets,
 Replovka,
 Round Borsdroff,
 Red Raspberry,
 Revel Glass,
 Reinette Red,
 Ranakouski,
 Revel,
 Revel Pidgeon,
 Red Titka,
 Red Streak,
 Russian Seedlings,
 Nos. 1, 2 & 3,
 Simbrisk,
 Skirsch Apple,
 Stepanoff,
 Sweet Miron,
 Sweet Borovinka.
 Striped Collville,
 Spiced Aromatic,
 Sweet Streaked,
 Shining Aromatic,
 BSaxonia,
 Scented White.
 Sweet Ripka,
 Smoky Arcad,
 Shepherd,
 Silken,
 Thaler,
 Throne,
 Tiesenhansen,
 Tasknskoe,
 Tilnoe,
 Tonka Crab (Pearse)
 Titovka,
 Titus of Veronesh,
 Tetofsky,
 Station Tetofsky Seedlings,
 Nos. 1, 2 and 3,
 Tubbs Iron Clad,
 Transparent Seed No. 1,
 Transcendant Crab,
 Ukraine,
 Ukraint,
 Unknown (Pearse)
 Unknown, 8 varieties Russian,
 Vasilist, largest,
 Vincent Wisconsin Seedling,
 Va. Crab,
 Visotskoe,
 Wolf River,
 White Naliv,
 White Skrute,
 Wisconsin Chief,
 White Pidgeon.
 Watermelon,
 Wealthy,
 Wealthy Seedling No. 1,
 Wild Apple, from Wisconsin,
 Winter Crab (Dartt),
 Wood Crab,
 Whitney No. 20 Crab,
 Wild Crab (Fluke)
 Witting Seed No. 1,
 Yearly's Winter,
 Yellow Annis
 Yellow Transparent,
 Yellow Sweet,
 Zakoritnoe.
 Zuzoffs Winter,
 Station Seedlings, 44 varieties, let-
 tered from A to &, and from AA
 to AQ.
 Station Seedlings, from Dartt's
 Hybrid, marked D. H., with Nos.
 from 1 to 29.
 Station Seedlings, from Thompson's
 Iowa Seedlings, 10 varieties.
 Station Seedlings, Greenwood Crab,
 20 varieties.
 Station Seedlings, Orange Crab, 100
 varieties.

PLUMS.

White Nicholas,
 Speer,
 Wolf,
 Black Prune,
 Rolling Stone,
 Forest Garden,
 Desota,

Rockford,
 Patton's Native,
 Weaver,
 Owatonna,
 Miner,
 Gates' Native,
 Early Red.

PEARS.

Russian, No. 347,
Russian, No. 391,
Russian, No. 381,

Russian, No. 392,
Russian, No. 345,
Longworth.

CHERRIES.

Tutovka,
Orel No. 24,
Unknown,

Sklanka,
23 Orel,
Utah Hybrid.

FOREST AND ORNAMENTAL TREES.

1 White Ash,
1 Black Cherry,
1 White Elm,
2 English Elm,
2 Scotch Elm,
2 European Alder,
1 Soft Maple,
2 Hard Maple,
2 Box Elder,
1 Bass Wood,
1 Butternut,
2 Black Walnut,
X Catalpa Speciosa,
X Russian Mulberry Seedlings,
X Teas Weeping Mulberry,
X Downing's Mulberry,
1 European Larch,
Hackberry,
X Weir's Cut-Leaf Maple,
2 Wisconsin Weeping Willow,
Populus Certinemis,
Alba Argastea,
Salix (Willow) Fragiles,
Hop Tree,
Populus Holeanna,
Populus Siberica,
Populus Mocha,
Populus Petriuski,
Cucumber Tree,
3 Norway Maple,
2 European Mountain Ash,
3 Tulip Tree,
Populus Boreallis,
X American Sycamore,
2 Kentucky Coffee Tree,
0 Yellow Birch,

1 American Mountain Ash,
1 Dogwood,
1 Native Thorn,
Populus 23 Riga,
Populus Lannfolia,
Populus Fastiga, or
X Lombardy Poplar,
122 Vor,
123 Vor,
127 Vor,
40 Riga,
Red Willow,
Elegans Augustifolia,
Salix Aurea,
2 Horse Chestnut,
Buckeye,
Persimmon,
Ohio Atlanthus,
Judas Tree,
Pecan,
Maiden Hair,
English Walnut,
Oak Leaf Mountain Ash,
2 European White Birch,
Canoe Birch,
2 Cut Leaf Weeping,
Hornbeam,
Choke Cherry,
Pea Tree,
Purple Beech,
Red Oak,
1 Cottonwood,
1 Dwarf Juneberry,
Crategus Sanguinea,
Purple Leaf Birch.

EVERGREEN TREES.

1 White Spruce,
1 Little Gem Arborvitæ,
1 American Arborvitæ,
1 Golden Arborvitæ,
3 Siberian Fir,
2 Austrian Pine,
3 Hemlock Spruce,
2 Douglass Spruce,
1 Norway Spruce,
3 White Tipped Arborvitæ,
1 Siberian Arborvitæ,
2 Pyramidal Arborvitæ,

2 White Pine,
2 Juniper, Com,
1 Scotch Pine,
1 Dwarf Mountain Pine,
3 Cedar, Red,
Red Pine,
0 California Pine,
0 Eastern Spruce,
0 Nordman's Fir,
2 Colorado Blue Spruce,
Picea Pungens.

. SHRUBS AND CREEPERS.

Artemisia,	Patentella Fruticosa,
1 Alpine Bear Berry,	1 Privet,
Wild Blackberry,	1 Purple Leaf Barberry.
Wild Bush Blueberry,	Caragani Arandi,
Wild Spirea,	Caragani Pygmea,
Wild Currant,	Caragni Redowski,
Spirea Philadelphus,	Siberian Lilac, blue,
Spirea Van Houttii,	Clematis Coclinea,
Spirea Nobleanna,	Ampelopsis Vetchi,
Spirea Douglass,	Bitter Sweet,
Spirea Derxia,	Pink Honeysuckle,
High Bush Cranberry,	Wisteria American,
Marsh Cranberry,	Golden Spirea,
Ribes, 148 Var., (Currant),	Akabea Gantiba,
Rosa Rugosa, or	1 Virginia Creeper,
White Japan Rose,	