

SEVENTEENTH ANNUAL REPORT

OF THE

AGRICULTURAL EXPERIMENT STATION

OF THE

UNIVERSITY OF MINNESOTA

Fiscal Year, July 1, 1908, to June 30, 1909



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1909.

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T. P. COOPER, B.S. in Agr. Assistant in Agriculture

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

MINNEAPOLIS, MINN., July 1, 1909.

To His Excellency, John A. Johnson, Governor of Minnesota:

I have the honor to transmit to you herewith the annual report of the Agricultural Experiment Station of the University of Minnesota for the fiscal year ending June 30, 1909.

JOHN LIND,
President Board of Regents.

List of Bulletins Published during the Fiscal Year,
Ending June 30, 1909.

	PAGES
PRESS BULLETIN No. 32.—Insects Affecting Wheat and Other Grains in Minnesota during 1907 and 1908.	
PRESS BULLETIN No. 33.—Some Destructive Shade Tree Pests.	
PRESS BULLETIN No. 34.—Spraying for the Plum Curculio.	
PRESS BULLETIN No. 35.—Lessons in Practical Forestry.	
PRESS BULLETIN No. 36.—Quack Grass Eradication.	
BULLETIN No. 110.—Northwest Experiment Farm. Installation of an Experimental Drainage System at Crookston	1-100
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BULLETIN No. 112.—Division of Entomology. The Apple Leaf Hopper and Other Injurious Insects of 1907 and 1908.....	145-254
BULLETIN No. 113.—Veterinary Division. Hog Cholera and Hog Cholera Vaccine	255-284
BULLETIN No. 114.—Division of Horticulture. Potato Experiments and Studies at University Farm. Potato Growing for Minnesota	285-362
BULLETIN No. 115.—Division of Agriculture. Seed Grain—Selection—Treatment—Varieties	363-384
BULLETIN No. 116.—Report of the Northeast Experiment Farm, Grand Rapids, Minnesota	385-420

REPORT

OF THE

Director of the Experiment Station.

To the President of the Board of Regents:

Herewith I have the honor to submit the seventeenth annual report of the Agricultural Experiment Station of the University of Minnesota and the two sub-stations at Crookston and Grand Rapids, for the fiscal year ending June 30, 1909. The report includes Bulletins 110 to 116 inclusive, a full statement of receipts and disbursements for the year and an outline of the work done in the different divisions.

Respectfully submitted,

J. W. OLSEN,

Director.

The Minnesota Agricultural Experiment Station in Account with
the United States Appropriations, 1908-1909.

Dr.	
To receipts from the treasurer of the United States as per appropriation for fiscal year ending June 30, 1909, as per Act of Congress approved March 2, 1887	\$15,000.00
Cr.	
By Salaries	\$8466.63
Labor	
Publications	1052.85
Postage and stationery	87.39
Freight and express	
Heat, light, water and power	2548.55
Chemical supplies	339.73
Seeds, plants and sundry supplies	316.33
Fertilizers	
Feeding stuffs	1592.61
Library	
Tools, implements and machinery	23.00
Furniture and fixtures	97.11
Scientific apparatus	327.60
Live stock	
Traveling expenses	88.84
Contingent expenses	15.00
Buildings and land	44.36
Balance	
	<hr/>
	\$15,000.00 \$15,000.00

Dr.	
To receipts from the treasurer of the United States as per appropriation for the fiscal year ending June 30, 1909, under Act of Congress approved March 16, 1906	\$10,930.09
To balance from appropriations for 1907-1908.....	69.91
Cr.	
By Salaries	\$8262.31
Labor	1340.84
Publications	
Postage and stationery	
Freight and express95
Heat, light, water and power	2.88
Chemical supplies	9.88
Seeds, plants and sundry supplies	9.78
Fertilizers	
Feeding stuffs	163.78
Library	
Tools, implements and machinery	44.60
Furniture and fixtures	200.00
Scientific apparatus	649.53
Live stock	
Traveling expenses	46.43
Contingent expenses	
Buildings and land	43.60
Balance	225.42
	<hr/>
	\$11,000.00 \$11,000.00

Financial Statement.

Statement of disbursements and receipts of the Minnesota Experiment Station for the twelve months beginning July 1st, 1908, and ending June 30, 1909, inclusive:

	Receipts.	Disbursements.	Cash Outlay
Agriculture	\$2,394.20	\$14,212.41	\$11,818.21
Animal Husbandry	3,464.24	10,170.06	6,705.82
Chemistry		1,306.72	1,306.72
Dairy Husbandry		137.71	137.71
Entomology		439.05	439.05
Horticulture	448.08	3,100.14	2,652.06
Station	142.63	21,330.15	21,187.52
Veterinary	26.10	1,965.13	1,939.03
	<hr/>	<hr/>	<hr/>
	\$6,475.25	\$52,661.37	\$46,186.12
Crookston	3,082.91	11,082.91	8,000.00
Grand Rapids	3,830.12	8,830.12	5,000.00
	<hr/>	<hr/>	<hr/>
	\$6,913.03	\$19,913.03	\$13,000.00

DIVISION OF AGRICULTURE.

The investigations in the Division of Agriculture during the year of 1908-09 have been mainly confined to four specific lines:

1. Plant breeding.
2. Crop Rotation.
3. Farm Management.
4. Cost of Production Statistics.

Numerous miscellaneous investigations have been made which bear a close relationship to all of these lines.

Eight hundred bushels of No. 2 rye were distributed in the fall of 1908 to one hundred forty growers. Reports so far received indicate that this variety is proving to be a high yielder and well adapted to Minnesota conditions. It has again demonstrated the efficiency of nursery methods of variety development. There is on hand at the present time sufficient winter wheat seed of an improved hardy variety to sow thirty to forty acres, and it is hoped that this may prove to be a sufficient amount to warrant the distribution of a hardy winter wheat during the coming year. Two new varieties of oats, Minnesota No. 281 and No. 289, also developed by rigid selection, have been increased in large quantities and we now have approximately

one thousand bushels of each for distribution during the coming crop season. Work is being continued in the development of new varieties and a number of very promising crosses between spring and winter wheat have appeared during the year. In co-operation with the Division of Botany and Plant Pathology, we are continuing the search for rust resistant varieties of wheat. Valuable scientific results have been secured during the year which need further support and investigation before publication. In co-operation with the U. S. Department of Agriculture, much valuable work has been originated in barley breeding and some new work is being done with grasses. The alfalfa breeding especially has given good results during the past year and we are satisfied that we have found in the Grimm alfalfa a hardy and very valuable variety for the Northwest.

The crop rotation work in field "C" has been continued. This year closes the third five-year period. Results are being compiled and tabulated for publication in crop rotation and farm management bulletins. The value of this work becomes more apparent as it continues. The effect of continuous cropping and the behavior of land under different systems of rotation, offer valuable lessons in the management of farms.

Under the farm management investigations, seventy-eight plots have been added to the rotation experiments. The object of the investigation is to determine the best method of handling land under various conditions, the proper method of applying manures, the effect of plowing at different seasons, and the comparison of various methods of handling the land. It is hoped that these investigations may be continued for a long period, as the accumulative results of rotation experiments are of far reaching value.

The rural statistical work is continued, the results of the first six years' work having been compiled and published by the Bureau of Statistics, U. S. Department of Agriculture, as Bulletin No. 73. The stereotype plates have been furnished to the station by the U. S. Department of Agriculture and the material is ready for publication as a

state bulletin. Bulletins are also in preparation on various phases of crop production.

Two new lines of work have been added to those already in existence during the year, that of investigations in quack grass eradication and tobacco culture. Special appropriations were made by the Legislature and work started immediately in the spring of 1909 in both of these lines. Several plot experiments have been conducted throughout the season, with a view of learning the life history of quack grass and the habits of growth of the plants. Plot experiments have also been conducted on rented land near University Farm as preliminary to more extensive work in large fields.

DIVISION OF AGRICULTURAL CHEMISTRY.

In the Division of Agricultural Chemistry a study is being made of the economic use of fuel in the cooking of food. The efficiency of home-made fireless cookers in which heated soap stones are used is being investigated. In January Mr. J. A. Hummel, Assistant Chemist, was assigned to denatured alcohol investigations. A special appropriation has been granted by the Legislature for a denatured alcohol plant. A small still imported from France was used in the determination of the alcohol yield of miscellaneous farm products. This still produced a dilute alcohol which was concentrated in a small rectifier patterned after those in use in large distilleries.

A large number of miscellaneous analyses have been made of agricultural materials for citizens of the state and also analyses for other divisions of the station.

DIVISION OF ANIMAL HUSBANDRY.

In the Division of Animal Husbandry, material has been compiled during the year for a bulletin on forage crops for sheep.

In addition to studies in sheep forage, considerable attention has been given to forage crops for swine, especially with a view of learning their value and efficiency in growing young pigs. Continued work has been carried on in hogging off corn and additional work is contemplated. Care-

ful studies of wool have also been made and valuable data and illustrations are in hand concerning this staple crop. The investigations cover the length and strength of wool, the effect of feed and age upon the strength of the wool fibre, and the effect of care and housing on the condition of the fleece.

In beef production the work covering the types and breeds of steers has gone forward with considerable success during the year. We have grown about twenty head of cattle that will be used in comparison of beef and dairy types. This investigation calls for a large amount of chemical and mechanical analyses and cannot be completed for several years. The work in feeding rations for sheep was disturbed last winter by conditions which could not be controlled and the result so far obtained will need to be supplemented by an additional winter's work. The breeding herd belonging to the college and station has been maintained in good condition, though most of the work in steer and swine feeding contemplated last year was abandoned on account of the great expense of feed and the lack of suitable stable room for such work.

DIVISION OF DAIRY HUSBANDRY AND ANIMAL NUTRITION.

In this division the investigation that has been carried on for several years in the nutrient requirements in milk production has been completed and a bulletin is being compiled. This bulletin will include data covering experiments made yearly since 1904. The feeding experiments have been continued and the feeding standard formulated a few years ago and based on the results of these experiments has been given a most thorough trial. It is a scientific and practical standard and by its use the dairyman is enabled to feed economically and secure a large flow of milk from his cows.

At the last session of the state legislature \$6,000 was appropriated for the use of this division for dairy extension work. A large number of dairy meetings have been held and an expert has been furnished county fair associations to judge the dairy stock. One man is detailed to the work

of inaugurating cow testing associations and the results obtained in this work are highly satisfactory. It is the purpose of the chief of this division to enlarge upon this work as circumstances will permit.

The new work in animal nutrition which was inaugurated in February, 1908, is being carried on in a careful manner, and some valuable data are being obtained. Four groups of calves have been set aside for this work and a most exhaustive record system has been followed in carrying on the work. This is a very important work and it is the intention of the chief of the division to devote practically his entire time to it. A laboratory is being installed in dairy hall for the purpose of facilitating analyses connected with this work.

Appropriations for remodeling dairy hall and completing the new dairy barn will be available August 1, 1910, and the division will thereafter be enabled to carry on the several branches of its work in a manner heretofore impossible on account of lack of room and equipment.

DIVISION OF ENTOMOLOGY.

The Entomological Division has done what it could to allay the excitement due to exaggerated reports of the green bug, and has endeavored to place before the people of the state trustworthy statements as to these and other insects affecting grain. The work has been continued against the apple leaf hopper, and the cabbage maggot. Investigations have been begun in the life history of *Bruca-phagus funebris* affecting clover.

The division in the course of its inspection work has done everything possible to urge upon nurserymen the importance of stamping out crown gall. Spraying experiments have been continued against the *plum curculio* upon apples and plums.

In addition to the regular publications of the station, this division has issued circulars on Destruction of Lawns by the White Grub, Cabbage Maggots on Radishes, San Jose Scale Possibilities in Minnesota, and Household Insects—the Housefly and the Clothes Moth.

Over four hundred experiments were carried on in the insectary. These embraced work with the bee moth,

clothes moth, confused flour beetle, various plant lice, stalk borer and oak pruner, the maple borer and borer found in birch and elm, the apple leaf hopper, and insects affecting clover.

The entomologist has in preparation a colored chart showing injurious insects and some useful birds of Minnesota. About nine thousand five hundred copies of this chart will be made and a copy sent to every school in the state which applies for it.

During the year about one hundred boxes of nursery stock imported from France and Holland and forwarded from New York to Minnesota florists and nurserymen have been inspected, the entomologist having been deputed to do so by the U. S. Department of Agriculture. This inspection was to prevent the introduction into this state of the gipsy and brown-tailed moths.

DIVISION OF HORTICULTURE AND FORESTRY.

At University Farm the chief experiment work in horticulture and forestry carried on during the year just closed, has been in connection with the testing of potatoes. The results of this work were published in bulletin No. 114. This included the report on the testing of about seventy new varieties, on experiments for the suppression of diseases and insects injurious to potatoes, the work with commercial fertilizers on potatoes, experiments to determine the quantity of seed to be used to best advantage, the improvement of the potato by means of selecting the best hills, the classification of different varieties of potatoes, and the study of flowers with a view of determining the factors which make for the production of potato seed. These matters are fully described in this bulletin. Work has also been carried on in the improvement of tomatoes by crossing and several promising seedlings have resulted.

In the line of forestry the chief experiment work at University Farm has been along the line of determining the best method of sowing Norway and white pine seed and

especially with the various treatments to prevent injury from the "damping-off" fungus.

The importance of the florists' industry in this state has been recognized to some extent and experiments carried on with a view of determining the best varieties of florists' annuals for this section have attracted much favorable comment.

At the Fruit Breeding Farm at Zumbro Heights, a complete drainage system has been put in to drain a number of small low spots. To do this, nearly 9,000 feet of clay tile were laid and the results have been satisfactory. A new six-inch well 250 feet deep has been put in and connected with a pump run by a gasoline engine, and the water service improved in several minor particulars. At this farm, the seedling work with apples, plums, strawberries, raspberries, blackberries and gooseberries has received most attention. During the winter the greenhouses were used for hand crossing of strawberries, raspberries, gooseberries and a few other fruits. Work of this kind in the greenhouses has the advantage over outside work in that the conditions can be absolutely controlled and much better results obtained. Three thousand seedling strawberries fruited this year and one hundred seedlings have been selected as promising for further experimentation. Over one thousand raspberry seedlings have fruited this year and about twenty will be saved for further experiment work. The work with raspberries is attracting much attention from fruit growers as the production of a new good raspberry would mean a large financial gain to small fruit growers. Special work is being carried on in the way of securing crosses with our best American and English gooseberries; also to secure crosses between the Japanese and native plums, the object being in each case to improve the size and quality of the fruit and to combine it with the hardiness of our native kinds. The staple crops at the Fruit Breeding Farm have been fairly good. About eight acres of pasture land have been cleared and broken. These will be needed for the increased work in fruit breeding.

In the line of forestry the most important work done is perhaps that of putting in experimental fire breaks about

Itasca Park, and when this system is completed there will be about forty miles of these fire breaks. In Itasca Park the small coniferous seedlings have been destroyed for a number of years by mice and other vermin. Last year nearly eighty pounds of white pine seed were sown in the park for experiment purposes to determine the best way of overcoming this injury. The seed germinated well but the seedlings were destroyed by mice when just out of the ground. Our experiments lead us to believe that the only satisfactory way of raising seedlings under such conditions is to protect the beds entirely by wire screens although we have accomplished something by treating the seeds with various poisonous or obnoxious substances.

About three thousand fence posts composed of bass wood, cotton wood, willow, birch, hard maple, red oak, and ash have been treated with preservatives the past year in co-operation with the United States Government and some of the results obtained are of great interest and will be referred to at considerable length in a bulletin now nearly ready for publication. The possibilities in the way of using our cheap woods to replace the more expensive kind for various purposes by preservative treatments are not generally realized. It can easily be demonstrated that cotton wood and willow posts properly treated with wood preservatives will last as long or longer than our best cedar posts. If the farmers of our prairies can be shown how to treat these and other cheap woods and make them more satisfactory and less expensive than those they are now using, it is an important matter. The last Legislature recognized this and made an appropriation of \$1,500 a year for the biennial period to carry on experiments in this line.

CLOQUET RESERVE.—Due largely to the enterprise of certain large lumber manufacturers in this state, legislation was secured by Congress, supplemented by state legislation and appropriations, by which the Forestry division of the University secures a forest tract in the Fond du Lac Indian Reservation containing 2,700 acres. This is admirably adapted for experiments in forestry both in the field and in connection with the large number of lumber-

their present condition as to fertility. Soils have been collected from various localities representing those that have been subjected to different methods of farming for various periods. The income and outgo of fertility from plots on University Farm are also being determined, and the humus investigations as previously reported are being continued. Experiments relative to the influence of fertilizers upon the various soil types are in progress, also as to the comparative value of various fertilizer materials. The material for a bulletin on Minnesota Soil Types has been prepared for publication.

NORTHEAST EXPERIMENT FARM.

The crops grown under field conditions were wheat, oats, barley, peas, clover and timothy, stock roots, potatoes, fodder corn and field corn. The yield of all the crops was normal with the exception of oats, which had been badly affected with rust throughout the growing season.

Under plot conditions several varieties of the different kinds of grains, potatoes, etc., were grown for test of yield, quality, etc. No variety was found that showed marked superiority over the varieties that have proved most satisfactory on the farm through past years. One variety of English oats and one variety of English barley gave indications of merit and were selected for special test. Their yield, however, under the first test was not greater than the standard varieties. In the test of varieties of field corn for grain, two varieties were found that seem best adapted to this section, the Northwestern Dent and Minnesota No. 23, a white cap dent. Of these two, Minnesota No. 23 gives indication of most quality. For fodder corn, nothing has been found more satisfactory than Minnesota No. 13.

The system of crop rotation that has been in operation for the past four years on the farm to demonstrate a system of farming for this section of the state, is showing very satisfactory results. It is based upon dairying, and the dairy herd on the farm is being increased and improved in proportion. The foundation of the dairy herd five years

ago was common stock. The three past years a Guernsey sire has been used and the herd is being bred for special dairying and in a way that is practical for the average farmer. Records are kept of the milk and butter produced by each cow and of the feed consumed, for the purpose of formulating a systematic method of dairy stock improvement.

In connection with the dairy, hogs are raised to utilize the skim milk. A bacon breed, the large improved Yorkshire, is giving very satisfactory results. They are grown largely on clover pasture and skim milk and fattened on barley and peas, and produce a very choice quality of meat.

Apples as yet have not been successful because of winter killing. The soil upon which the orchard is located is sandy, which is regarded in some degree as accountable for the failure. Plums and all kinds of small fruits are doing well. Vegetables are grown with much success.

During November and December work was done in connection with the Farmers' Institute in Northeastern Minnesota, carrying the work of the station to the farmers so far as possible. Special meetings were held giving instruction in the clearing of land through the use of dynamite.

NORTHWEST EXPERIMENT FARM.

The drainage system installed the season of 1907 has been set forth as promised in Minnesota Bulletin No. 110. This was done in co-operation with the Office of Experiment Stations of the United States Department of Agriculture. Although the past two seasons have been rather dry, the benefits of the system have been very evident. The present season a number of tile lines were in operation by the eighth of April. As a result of the drainage and a favorable season, the 1909 crop of all kinds promises to be the best ever grown on the farm.

Minnesota No. 169 wheat again demonstrated its superiority in yield over all other varieties planted, all yields how-

ever being light on account of drouth. The other varieties grown were Minnesota No. 188, United States No. 5835 (Durum), Minnesota No. 163, and United States No. 5800 (Durum), the yields from the largest to smallest being in the order named.

Of the two varieties of oats grown, Minnesota No. 230 and Swedish Select, the Minnesota No. 230 yielded nearly a half more.

Three varieties of dent corn, Minnesota No. 13 and No. 23, and Pride of the North, were matured in field lots. Minnesota No. 23, although planted late, yielded 27.7 bushels per acre.

Clover and timothy gave much lighter yield than in 1907 on account of drouth. A small patch of first-crop clover cut for seed demonstrated that northern Minnesota can save seed from either first or second crop of clover.

Can alfalfa seed be grown in the Red River Valley? To test this a small patch was left in 1908 after the first cutting for hay. Four and one-half pounds of seed were threshed and planted in the spring of 1909 by the side of the five varieties seeded in 1908. This home-grown seed started out much more vigorously than did the last year's plots. All of last year's (1908) plots came through the winter in good shape, and will be ready for the second cutting by the middle of August. The promising condition of the alfalfa sown last year and the persistency of the planting of former years lead to the conclusion that alfalfa will yet be grown extensively in this region.

The ten acres of Canadian field peas grown the season of 1908 gave fairly promising results. The growth was too rank for usual harvesting, so aside from what was required for seed the crop was cleaned up in a thorough manner by a bunch of sheep, poultry and swine running on the territory for two months in the fall. The peas are on trial for the season of 1909, along with oats.

The poultry plant continues to grow in popularity with the farmers. About two hundred hens are being trapped the year around. From the product of the best of these is selected the breeding stock which is being sold.

About two hundred males besides many pullets and eggs went out the past year to improve the farmer's hen. That the work of the plant is appreciated even beyond the borders of the state, is shown by the fact that our stock has gone to California, Washington, Montana, and eastern Canada. Another poultry bulletin is now ready for the press.

Our flock of sheep consists of grade Shropshire with a pure bred Shropshire ram. The average clip for the spring of 1909 was 8.9 pounds. The lamb crop for 1909 was 114%. The flock is in a thriving condition.

The cows milked are Holstein, Shorthorn, and grades of each. The spring balance and the Babcock test determine largely what cows shall remain in service. Some very good records were made the past year.

ing establishments which are located near by and which assure us of their hearty co-operation in this work.

VETERINARY DIVISION.

In the veterinary division the experiment work may be grouped into the following:

- (a) Production of hog cholera vaccine and experimental work in connection with the same,
- (b) Investigational work with diseases illustrated by work already done or in progress with swamp fever, tuberculosis, and infectious abortion,
- (c) Experimental work with medicines as to range of usefulness or efficiency, and testing new medicines or new uses of old medicines.

The loss every year from hog cholera in the United States is enormous. Even in one state like Minnesota the average losses during a term of years have been very serious, single year losses running over a million dollars. Anything this station can do to check the spread of the disease or in any way lessen its loss is evidently a matter of great importance. The veterinary division is producing a vaccine which promises to be a great help to the live stock interests of Minnesota.

This work was started in a very small experimental way in November 1907 and has gradually developed until a considerable amount of vaccine is being produced. A new building is being erected at University Farm expressly for the production of hog cholera vaccine.

The first problem taken up was concerning the efficiency of the vaccine and the results of the tests were very satisfactory.

Possible dissemination by vaccination was the next study. Inasmuch as the use of virulent blood in connection with the immunizing serum forms a part of one of the vaccination methods, it seemed possible that there might occur serious spreading of cholera in new districts by this vaccination method. The conclusion was that danger from this source was so slight that it might be safely dis-

regarded. In the course of this work a number of vaccinated hogs have been closely exposed without harm with cholera hogs that were sick and dying, and pigs have been treated with the vaccine and then given injections of virulent blood. With potent serum and virulent blood properly used, the vaccine has protected very uniformly. Farm outbreaks of hog cholera have been checked, and the outlook is very promising for a work of great importance.

In one experiment fifty-one suckling pigs were inoculated with virulent blood and then treated with the protecting serum with the result that all of the pigs were saved, whereas a very large portion, perhaps all of them, would have died from the inoculation if the vaccine had not been given, since the blood was proved virulent on previous test.

Four important questions yet to be solved by careful work are:

- (a) Increasing potency of the serum so that a smaller dose may be used and at a proportionately smaller expense,
- (b) Lessening cost of production,
- (c) Standardizing the serum as to potency,
- (d) Preserving virulent blood without destroying its efficiency.

Up to January 1, 1909, the serum was used entirely for demonstration and test purposes and free of expense to owners. Since January 1st, the plan has been to sell the vaccine at cost of production and to make the vaccine plant approximately self-supporting.

Up to December 1, 1908, there were vaccinated in herds already infected, two hundred and fifty-one hogs, of which forty-four died. In the same herds, seventy-six were vaccinated, of which sixty-eight died. During this same period two hundred and one healthy hogs in herds not infected with cholera were vaccinated, of which two died some time after vaccination, neither showing satisfactory evidence of cholera. The actual results of vaccination were tested in all these cases by exposure with sick hogs or by

inoculation with virulent blood, making a very satisfactory showing for the serum.

Research work in the study of stable ventilation has been under way for several years. As any work reported or an expression of opinion on such a subject is apt to be misquoted and misunderstood it should be noted that there is nothing in this work to suggest that ventilation is unnecessary.

This work at the Minnesota Experiment Station is along very original lines and has already attracted very wide interest and recognition. It is now supported by the government under what is known as the Adams Fund. Thus far all work has been purposely confined to the study of the confined animal—cattle and rabbits being used. Methods of stable ventilation constitute an entirely different phase of the subject, and will be taken up later. Surprising results in connection with work already done by the veterinary division of our experiment station has been confirmed in part by work since reported by Dr. Atwater, working under federal supervision but with human beings. It seemed necessary first of all, to locate and define the injurious effects which may come from insufficient ventilation and to establish a standard for comparing such injurious effects.

The essential questions at issue have been :

Is unventilated air harmful? If so, where and how is injury produced and under what circumstances?

How much ventilation is really necessary to prevent such harmful results, and to give comfort and economical feeding?

Especially prepared stalls are used with the ventilation conditions under control. Animals are studied in free air and then in unventilated stable air for periods varying from a few hours to many weeks. Careful records are kept of the animal's physiological condition including studies of the blood and urine while confined in free air and in unventilated experimental stalls. This work has been badly hampered during the past year by lack of needed laboratory help, which lack will soon be relieved.

From this original work it seems probable :

(1) That any probable stable increase of carbon dioxide gas or decrease of oxygen is not seriously important,

(2) That when animals confined in unventilated stables are injuriously affected, it is because of factors other than increase of carbon dioxide gas or decrease of oxygen. It may be due to concentration of disease producing germs, lack of exercise, lack of sunshine, and probably other factors not now understood,

(3) That the amount of carbon dioxide gas in the stable air is a very unreliable guide as to the hygienic conditions of the atmosphere,

(4) That it is unnecessary to plan ventilation shafts or any portion of a stable ventilation system with a special view to removing carbon dioxide gas.

Swamp fever is a strange disease which causes serious losses in Minnesota, particularly in the western and northern portions of the state. Practically nothing has been known until recently concerning cause, method of spread, or real nature of the disease, and sanitary authorities have been accordingly helpless in any attempt to deal with it. This work has been under way for several years and is done in co-operation with the federal Bureau of Animal Industry and our State Live Stock Sanitary Board. A special stable of nine stalls was constructed at University Farm by the Sanitary Board during the year. This stable gives greatly increased facilities for this work. From six to ten horses are now in constant use. We have suitable stabling facilities for thirteen horses, with each one carefully isolated.

As a result of this work it has been shown that swamp fever is caused by a microscopically invisible living germ and not by intestinal parasites, poisonous plants, or body poisons, as have been variously claimed. It has been shown that this disease is easily transmissible by inoculation among horses and mules and that the living virus occurs in the blood at least nineteen days before death and for twenty-four hours after death. At present infec-

tion by manure and urine in sick horses is being tested. An experiment will soon be under way testing infection by stable exposure with a sick horse.

A number of very typical cases have been produced artificially in the course of this work. Definite information has been secured concerning the incubation period of the disease and evidences found on autopsy. It is hoped that future work may define the nature of the virus and possibly isolate it. We hope to determine how the virus escapes from the body and to secure information concerning the common ways in which the disease is contracted, whether through the alimentary canal or by respiration, or through inoculation: *e. g.*, by flies and mosquitos. We hope to determine also a full list of susceptible animals: *i. e.*, animals which may contract the disease and thus serve as agents of dissemination and finally, a prevention or treatment.

The prevalence of tuberculosis among cattle and the importance of the subject is so generally understood that no explanation seems necessary concerning the importance of anything which may tend to restrict the disease. Some experimental work has been under way in this division of the station for several years in connection with Dr. von Behring's anti-tuberculosis vaccine for calves. Quite a large number of calves have been used in experimental work at University Farm, at several private breeding farms, and at state institutions where herds of cattle are kept.

In the first series of experiments now finished, this vaccine was purposely tested under ordinary farm conditions and in the way that it would commonly be used on private farms and not according to certain of von Behring's specific directions. A second series of experiments is now under way with calves at state institutions at Rochester, Fergus Falls, and Faribault. In these experiments effort is made to comply with von Behring's rules. These calves will be kept under observation as long as possible with a view of determining the relative number of vaccinated and unvaccinated calves which subsequently become tubercular.

The probable relation between human and bovine tuberculosis and the prevalence of the latter make work of this kind a thing of great importance for the entire public.

Some work has been done in connection with the dairy division, studying the control of infectious abortion, a seriously threatening disease of breeding herds. The question taken up has been the method of dealing with an infected herd including treatment for the affected cow. Various internal disinfectants have been tried at various strengths with a view of comparing efficiency and in the hope of finding one which would be efficient and at the same time as slightly irritating as possible when used internally. It has been shown that carbolic acid when used internally in very large doses has considerable power in the way of preventing a threatened abortion. It has also been shown that enormous doses, many times larger than have previously been supposed safe, may be used with impunity.

Manuscript for two technical bulletins on the stable ventilation work is nearly ready for publication. At least another year will be required before we will be ready to publish anything on swamp fever, or von Behring's anti-tuberculosis vaccine. Two bulletins, one each on infectious abortion and pasture dissemination of tuberculosis, are nearly completed.

DIVISION OF BOTANY AND PLANT PATHOLOGY.

This division entered on its second year of work January 1st, 1909. The work of organization and equipment has been continued and considerable advance made. The survey of plant diseases in the state has been pursued with more facility than in the preceding year. The co-operation of the Disease Survey Department of the United States Department of Agriculture has been found very useful. An increasing number of requests for identification and information regarding various diseases of plants have been received.

The work on rusts and smuts of cereals has occupied, as before, considerable attention of this division. Various

experiments of a confirmatory nature for Minnesota conditions have been undertaken in the treatment of different smuts and satisfactory results obtained. The methods for the treatment of loose smut of wheat and barley which have been worked out in part at this station, have again been tested and found efficient. A disease plot has been established at the Experiment Station remote from other crops, and in this plot the disease work has been carried on. A rust plot was established here in which a vigorous epidemic of rust was obtained by artificial means, while in neighboring fields of the same grains almost no rust appeared. In view of this fact the division is now apparently capable of proceeding with the work on selection and hybridization and other experiments in regard to the rusts of grains with more certainty than heretofore, since it will very probably be possible to reproduce this small local epidemic every year. None of the grain fields on University Farm outside of this plot were at all seriously affected by the rust. A large number of hybrids are being tested for their resistant qualities and many other experiments relating to the life histories of the rusts and their relationship to the cereal plants are being carried on.

Work has been commenced on the fruit diseases of Minnesota, especially brown rot of plums, plum pocket, and scab of apples, also the diseases on small fruits. Preliminary spray work has been started with some success. Experiments in spraying treatments for dodder on various plants have proven partially successful.

The work on weeds has also occupied considerable attention. This has been confined largely to the identification of weed and seed samples sent to this station and also to the collection of weed samples and seed samples to aid in the identification. The division is now thoroughly equipped to make complete analyses and tests of seeds for farmers in the state. A considerable number of samples have been analyzed and tested during the past year. Enough has been done to indicate that there is much impure seed on sale in the state and that this branch of the work should be expanded.

A collection has been made of timber rots, preparatory to work on the preservation of timbers. Plans are being made for wood rotting cellars.

The division has been interested in the collection and dissemination of weed, seed and disease samples among schools for educational purposes. It has also attempted to assist the rural and high schools of the state toward the direction of more efficient instruction in these lines.

DIVISION OF AGRICULTURAL ENGINEERING AND PHYSICS.

The Division of Agricultural Engineering and Physics was created by the Board of Regents at the May meeting, 1908, and was officially organized August 1st, the same year. During the past year this division planned and supervised the construction of a system of 1.6 miles of underdrainage on the State Fruit Breeding Farm at Zumbro Heights, and eight miles of underdrainage on a farm near Halstad. Plans have been made for the thorough drainage of the Northeast Experiment Farm at Grand Rapids. A small irrigation experiment in which Irrigation Investigations, Office of Experiment Stations, U. S. Department of Agriculture, are interested, has been planned and laid out at Hubert.

Assistance has been given to drainage improvement throughout the state by correspondence and special reports. Experiments are now being made to determine the best equipment and method of making farm surveys where the work is not of sufficient extent to justify the employment of an engineer.

DIVISION OF SOILS.

During the year the Division of Soils was made a separate division and Professor Snyder was made Professor of Soils instead of Professor of Agricultural Chemistry and Soils as heretofore. He gives only a part of his time to the institution and is paid proportionally. Work now in progress includes a study of the soil types of the state and