

# The University of Minnesota

TWENTIETH ANNUAL  
REPORT OF THE  
AGRICULTURAL EXPERIMENT STATION



FISCAL YEAR, JULY 1, 1911  
TO JUNE 30, 1912

UNIVERSITY FARM, ST. PAUL  
MARCH 1913

# THE UNIVERSITY OF MINNESOTA

## THE BOARD OF REGENTS

The Hon. JOHN LIND, Minneapolis, President of the Board.....	1914
GEORGE EDGAR VINCENT, Minneapolis.....	<i>Ex-Officio</i>
The President of the University	
The Hon. ADOLPH O. EBERHART, Mankato.....	<i>Ex-Officio</i>
The Governor of the State	
The Hon. C. G. SCHULZ, St. Paul.....	<i>Ex-Officio</i>
The State Superintendent of Public Instruction	
The Hon. W. J. MAYO, Rochester.....	1913
The Hon. MILTON M. WILLIAMS, Little Falls.....	1913
The Hon. JOHN G. WILLIAMS, Duluth.....	1914
The Hon. A. E. RICE, Willmar.....	1915
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The Hon. PIERCE BUTLER, St. Paul.....	1916
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T. J. HORTON, Photographer  
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H. R. SMITH, B. S., Animal Husbandman  
J. S. MONTGOMERY, B. S. in Agr., Assistant Animal Husbandman  
T. G. PATERSON, B. S. in Agr., Assistant Animal Husbandman  
W. F. HAGERMAN, B. S. A., Assistant Animal Husbandman  
K. F. WARNER, B. A., Assistant in Animal Husbandry  
R. M. WASHBURN, M. S. A., Associate Dairy Husbandman  
E. O. HANSON, Assistant in Dairy Husbandry  
A. C. SMITH, B. S., Poultry Husbandman  
D. J. LANE, Assistant in Poultry Husbandry  
C. H. MATTHEWS, Assistant in Poultry Husbandry  
E. W. MAJOR, B. Agr., Associate, Animal Nutrition  
\*STEPHEN ANTHONY, Chemist in Animal Nutrition  
MILDRETH HAGGARD, B. A., Chemist in Animal Nutrition  
AGNES ERICSON, Assistant Chemist in Animal Nutrition  
W. F. CANTWELL, B. S. in Chem., Asst. Chemist in Animal Nutrition  
GRACE B. ANDREWS, Clerk and Computer  
M. KUGIMOTO, Assistant in Animal Nutrition  
M. H. REYNOLDS, B. S. A., M. D., D. V. M., Veterinarian  
C. C. LIPP, D. V. M., Assistant Veterinarian  
W. L. BOYD, D. V. S., Assistant Veterinarian  
H. P. HOSKINS, V. M. D., Assistant Veterinarian  
L. E. WILLEY, D. V. M., Assistant Veterinarian  
ANDREW BOSS, Agriculturist  
C. P. BULL, B. Agr., Associate Agronomist  
A. C. ARNY, B. S. in Agr., Assistant Agronomist  
L. B. BASSETT, Assistant Agriculturist  
F. W. PECK, B. S., Assistant Agriculturist  
F. L. WASHBURN, A. M., Entomologist  
\*A. G. RUGGLES, M. A., Assistant Entomologist  
C. W. HOWARD, A. B., Assistant Entomologist  
W. WILLIAMSON, M. A., Assistant Entomologist  
O. G. BABCOCK, B. S., Assistant Entomologist

\* Absent on leave 1912-1913

E. M. FREEMAN, Ph. D., Plant Pathologist and Agricultural Botanist  
W. L. OSWALD, Assistant Agriculturist and Seed Analyst  
E. C. STAKMAN, M. A., Asst. Plant Pathologist and Bacteriologist  
A. G. TOLAAS, M. S., Assistant in Agricultural Botany  
J. T. STEWART, C. E., Agricultural Engineer  
J. L. MOWRY, Assistant Agricultural Engineer  
H. B. ROE, B. S. in Eng., Assistant Agricultural Engineer  
J. B. FREAR, M. E., Assistant Agricultural Engineer  
RALPH HOAGLAND, B. Agr., Soils and Agricultural Chemist  
R. M. WEST, B. A., Assistant Agricultural Chemist  
W. H. FRAZIER, B. S., Assistant Soils Chemist  
G. W. WALKER, B. S. in Chem., Assistant Soils Chemist  
C. H. BAILEY, Assistant Cereal Technologist  
DE FOREST HUNGERFORD, B. S., Assistant Soils Chemist  
CORNELIA KENNEDY, B. A., Assistant in Chemistry  
P. R. MCMILLER, B. S. in Chem., Assistant in Chemistry  
LEROY CADY, B. S. in Agr., Horticulturist  
A. R. KOHLER, M. S., Assistant Horticulturist  
M. J. DORSEY, M. S. in Agr., Research Technologist in Fruit Breeding  
E. G. CHEYNEY, A. B., Forester  
J. P. WENTLING, M. A., Associate Forester  
J. H. ALLISON, M. F., Associate Forester  
W. H. KENETY, M. S., In charge of Cloquet Station  
A. D. WILSON, B. S. in Agr., Agricultural Extension  
C. W. THOMPSON, A. M., Agricultural Economist  
A. J. MCGUIRE, B. Agr., Superintendent, Grand Rapids Substation  
E. C. HIGBIE, A. M., Superintendent, Morris Substation  
C. G. SELVIG, M. A., Superintendent, Crookston Substation  
CHARLES HARALSON, Superintendent, Fruit Breeding Farm, Excelsior

## LETTERS OF TRANSMITTAL

MINNEAPOLIS, MINN., July 1, 1912.

*To His Excellency, Adolph O. Eberhart,  
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 ended June 30, 1912.

JOHN LIND,  
*President Board of Regents.*

MINNEAPOLIS, MINN., July 1, 1912.

*To the President of the Board of Regents, John Lind,  
University of Minnesota:*

I have the honor to transmit herewith the report of the Director of the Experiment Station for the fiscal year ended June 30, 1912.

GEORGE E. VINCENT,  
*President of the University of Minnesota*

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### EXPERIMENT STATION BULLETINS PUBLISHED DURING THE YEAR ENDED JUNE 30, 1912, AND BOUND AS PART OF THIS REPORT

	Pages
Bulletin 125—Farm Management, by W. M. Hays, Andrew Boss, A. D. Wilson, and T. P. Cooper.....	1-96
Bulletin 126, Technical—Lighting with Alcohol and Kerosene, by R. M. West.....	97-128
Bulletin 127—Seed Laboratory Report, 1910-1911, by W. L. Oswald .....	129-164
Bulletin 128, Technical—The Relation of Different Systems of Crop Rotation to Humus and Associated Plant Food, by G. W. Walker.....	165-186

Extension Bulletins and Press Bulletins are not included in full in this report. A list of the Extension Bulletins printed during this year may be found on page XL. The Press Bulletins printed were No. 40—Hog Cholera Serum, by Dr. M. H. Reynolds, and No. 41—Preliminary Report of the Purchase and Distribution of Grass Seed for the Benefit of Settlers on Burned-over Land.

THE MINNESOTA AGRICULTURAL EXPERIMENT STA-  
TION IN ACCOUNT WITH THE UNITED STATES  
APPROPRIATIONS, 1911-1912

Dr.

To receipts from the Treasurer of the United States in accordance with the appropriation for the fiscal year ended June 30, 1912, under Act of Congress approved March 2, 1887..... \$15,000.00

Cr.

By Salaries.....	\$11,833.35	
Labor.....	956.56	
Publications.....	686.24	
Postage and stationery.....	46.56	
Freight and express.....	2.46	
Heat, light, water, and power.....	74.20	
Chemicals and laboratory supplies.....	29.07	
Seeds, plants, and sundry supplies.....	342.66	
Feeding stuffs.....	403.49	
Library.....	168.19	
Tools, machinery, and appliances.....	15.88	
Furniture and fixtures.....	268.01	
Scientific apparatus and specimens.....	163.68	
Contingent expenses.....	9.65	
Total Hatch Fund.....	\$15,000.00	\$15,000.00

Dr.

To receipts from the Treasurer of the United States in accordance with the appropriation for the fiscal year ended June 30, 1912, under Act of Congress approved March 16, 1906..... \$15,000.00

Cr.

By Salaries.....	\$12,288.54	
Labor.....	1,226.42	
Postage and stationery.....	65.20	
Freight and express.....	2.88	
Chemicals and laboratory supplies.....	210.28	
Seeds, plants, and sundry supplies.....	53.84	
Feeding stuffs.....	60.01	
Tools, machinery, and appliances.....	112.83	
Furniture and fixtures.....	155.91	
Scientific apparatus and specimens.....	367.84	
Live stock.....	55.50	
Traveling expenses.....	299.83	
Buildings and land.....	100.92	
Total Adams Fund.....	\$15,000.00	\$15,000.00

## FINANCIAL STATEMENT

STATEMENT OF RECEIPTS AND DISBURSEMENTS, EXCLUSIVE OF BUILDINGS, OF THE DEPARTMENT OF AGRICULTURE FOR THE FISCAL YEAR  
1911-1912

### GENERAL SUPPORT

DIVISION	EXPERIMENT STATION			SCHOOL AND COLLEGE			
	Receipts	Disburse- ments	Net Cost	Receipts	Disburse- ments	Net Cost	Total
Agronomy and Farm Management .....	\$427.06	\$15,032.37	\$14,605.31	\$23.80	\$2,859.12	\$2,835.32	\$17,440.63
Agricultural Engineering .....		6,668.91	6,668.91		12,348.14	12,348.14	19,017.05
Plant Pathology and Botany .....		1,609.91	1,609.91		2,326.18	2,326.18	3,936.09
Chemistry and Soils .....		3,843.70	3,843.70	61.38	3,400.47	3,339.09	7,182.79
Dairy and Animal Husbandry .....	7,238.71	16,016.30	8,777.59	6,970.17	20,744.87	13,774.70	22,552.29
Entomology .....					2,408.30	2,408.30	2,408.30
Horticulture .....	553.92	4,731.91	4,177.99		1,998.48	1,998.48	6,176.47
School and College .....				22,751.09	56,393.79	33,642.70	33,642.70
Experiment Station .....	1,323.14	23,062.54	21,739.40				21,739.40
Veterinary .....	29.20	2,542.39	2,513.19	20.00	3,126.23	3,106.23	5,619.42
Forestry .....					2,928.74	2,928.74	2,928.74
<b>Totals .....</b>	<b>\$9,572.03</b>	<b>\$73,508.03</b>	<b>\$63,936.00</b>	<b>\$29,826.44</b>	<b>\$108,534.32</b>	<b>\$78,707.88</b>	<b>\$142,643.88</b>
Northwest School and Experiment Station .....	\$9,700.74	\$39,016.03	\$29,315.29				
North Central Experiment Station .....	7,140.67	13,625.22	6,484.55				
West Central School and Experiment Station .....	6,253.69	27,234.35	20,980.66				
<b>Total for maintenance .....</b>	<b>\$23,095.10</b>	<b>\$79,875.60</b>	<b>\$56,780.50</b>				

## SPECIAL STATE APPROPRIATIONS

## DISBURSEMENTS FOR MAINTENANCE 1911-1912

Eradication of Noxious Weeds.....	\$987.90	
Farm Management.....	1,422.51	
Field Crops.....	5,899.58	
Tobacco Investigations.....	2,149.96	
Total, Agronomy and Farm Management.....	—————	\$10,459.95
Agricultural Engineering Investigation.....	281.33	
Drainage Problems.....	1,810.63	
Repairs.....	10,086.49	
Total, Agricultural Engineering.....	—————	12,178.45
Plant Diseases.....	1,435.67	
Total, Botany and Plant Pathology.....	—————	1,435.67
Alcohol Investigation.....	2,728.33	
Flour and Grain Testing.....	2,021.69	
Soil Investigation.....	2,723.93	
Total, Chemistry and Soils.....	—————	7,473.95
Campus Improvement.....	1,688.72	
Fruit Breeding.....	2,315.62	
Fruit Farm Maintenance.....	1,985.15	
Horticultural Crops.....	1,779.00	
Total, Horticulture.....	—————	7,768.49
Animal Nutrition Investigation.....	1,996.16	
Dairy Extension.....	2,688.45	
Live Stock Purchase.....	10,440.42	
Poultry Extension.....	1,656.29	
Total, Dairy and Animal Husbandry.....	—————	16,781.32
Investigation of Injurious Insects.....	1,463.39	
Total, Entomology.....	—————	1,463.39
Forest Experiments.....	343.86	
Forest School Instruction.....	8,492.83	
Forest School Support.....	2,629.63	
Timber Preservation.....	1,054.26	
Total, Forestry.....	—————	12,520.58
Hog Cholera Investigation.....	5,504.78	
Total, Veterinary.....	—————	5,504.78
Library.....	5,365.04	5,365.04
Agricultural Extension.....	37,318.52	37,318.52
Premiums.....	1,782.25	1,782.25
Total.....	—————	—————
Total.....	\$120,052.39	\$120,052.39



## FEDERAL FUNDS

	Hatch	Adams	Nelson	Total
Agronomy and Farm Management.....	\$1,150.64	.....	\$2,393.16	\$3,543.80
Agricultural Engineering.....	18.00	.....	5,764.63	5,782.63
Plant Pathology and Botany.....	1.38	\$2,353.49	2,286.37	4,641.24
Chemistry and Soils.....	1,806.49	1,700.00	2,138.62	5,645.11
Dairy and Animal Husbandry.....	2,392.64	5,470.00	1,975.00	9,837.64
Entomology.....	1,600.00	2,034.30	742.61	4,376.91
Horticulture.....	1,600.00	1,650.00	2,100.00	5,350.00
Veterinary.....	1,616.50	1,738.71	1,363.46	4,718.67
School and College.....	.....	.....	6,160.78	6,160.78
Experiment Station.....	4,814.35	53.50	.....	4,867.85
Totals.....	\$15,000.00	\$15,000.00	\$24,924.63	\$54,924.63

## GENERAL SUMMARY OF DISBURSEMENTS FOR YEAR 1911-1912

	General Support	Special	Federal	Total
Agronomy and Farm Management.....	\$17,891.49	\$10,459.95	\$3,543.80	\$31,895.24
Agricultural Engineering.....	19,017.05	12,178.45	5,782.63	36,978.13
Plant Pathology and Botany.....	3,936.09	1,435.67	4,641.24	10,013.00
Chemistry and Soils.....	7,244.17	7,473.95	5,645.11	20,363.23
Dairy and Animal Husbandry.....	36,761.17	16,781.32	9,837.64	63,380.13
Entomology.....	2,408.30	1,463.39	4,376.91	8,248.60
Horticulture.....	6,730.39	7,768.49	5,350.00	19,848.88
School of Agriculture.....	56,393.79	.....	6,160.78	62,554.57
Experiment Station.....	23,062.54	.....	4,867.85	27,930.39
Veterinary.....	5,668.62	5,504.78	4,718.67	15,892.07
Forestry.....	2,928.74	12,520.58	.....	15,449.32
Library.....	.....	5,365.04	.....	5,365.04
Agricultural Extension.....	.....	37,318.52	.....	37,318.52
Premiums Industrial Contests.....	.....	1,782.25	.....	1,782.25
Totals.....	\$182,042.35	\$120,052.39	\$54,924.63	\$357,019.37
Total University Farm Maintenance.....	.....	.....	.....	\$357,019.37

TOTAL APPROPRIATIONS FOR BUILDINGS, LAND, AND IMPROVE-  
MENTS FOR BIENNIUM, 1911-1913

Ladies' Dormitory or Additions.....	\$50,000
Mechanic Arts Building and Equipment.....	160,000
for same, appropriated by 1909 Legislature.....	100,000
Hog House.....	2,500
Horse Barn.....	5,000
Repairing Dining Hall.....	5,000
Electric Wiring.....	4,000
Heating Tunnels.....	3,000
Power House Repairs.....	14,700
Finishing Basement, Girls' Dormitory.....	3,000
Replacing Equipment, Girls' Dormitory.....	2,000
Remodeling Old Barn.....	5,000
Water Mains, Fencing, Lighting, and Grading (\$1,000 in 1910).....	10,000
Sewers.....	10,000
Remodeling Drill Hall.....	10,000
	<hr/>
Total for University Farm.....	\$384,200
Less amount appropriated in 1909.....	100,000
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Total for Biennium, 1911-1913.....	\$284,200
Northwest School and Experiment Station.....	\$80,290
North Central Experiment Station.....	8,500
West Central School and Experiment Station.....	165,700
Northeast Demonstration Farm and Experiment Station.....	65,000
Southeast Demonstration Farm and Experiment Station.....	35,000
Total Substations.....	<hr/> \$354,490
Grand Total University Farm and Substations.....	<hr/> \$638,690

## REPORT OF THE DIRECTOR

*President George E. Vincent, University of Minnesota*

DEAR SIR: I have the honor to hand you herewith, for transmission to the President of the Board of Regents, the Twentieth Annual Report of the Agricultural Experiment Station of the University of Minnesota for the fiscal year ended June 30, 1912.

The financial report includes not only the money received from the United States Government, but also all special appropriations that are used for experimental or research work and the general university support money used for the same purpose.

There have been quite a number of changes in personnel during the year. The general demand for trained workers has been so great and the salaries have been so high, that it has been impossible to hold some of our men, who have had offers from other institutions. The following are among the more important resignations that occurred during the year:

James D. Bilsborrow, Agriculturist at Crookston  
Charles S. Spooner, Assistant in Entomology  
H. B. Scammel, Assistant in Entomology  
Richard H. Williams, Assistant in Animal Husbandry  
William H. Tomhave, Specialist in Live Stock  
George P. Grout, Assistant in Dairy Husbandry  
Thomas P. Cooper, Assistant in Agriculture

The following new appointments were made:

H. R. Smith, Animal Husbandman  
M. J. Dorsey, Research Technologist in Fruit Breeding  
C. W. Thompson, Chief of Bureau of Research in Agricultural Economics  
R. M. Washburn, Assistant Dairy Husbandman  
J. S. Montgomery, Assistant Animal Husbandman  
W. L. Boyd, Assistant Veterinarian  
H. P. Hoskins, Assistant Veterinarian  
L. E. Willey, Assistant Veterinarian  
F. W. White, Assistant Animal Husbandman  
L. B. Bassett, Assistant in Farm Management  
C. H. Bailey, Cereal Technologist  
F. W. Peck, Assistant Agriculturist  
C. W. Howard, Assistant Entomologist  
W. Williamson, Assistant Entomologist  
O. G. Babcock, Assistant Entomologist  
W. H. Cantwell, Assistant in Animal Nutrition  
P. R. McMiller, Assistant in Soils  
De Forest Hungerford, Assistant Soils Chemist

A new division was established during the year for the purpose of conducting research in agricultural economics with special reference to marketing. It is planned to broaden the field as rapidly as experience warrants.

The Fruit Breeding Farm at Zumbra Heights has completed much of its preliminary work. A large number of hybrids and varieties of plums, apples, and small fruits have been developed. The practical work of selection and distribution is now commencing. A new line of work under the Adams Fund has been recently started in the investigation into the scientific principles underlying fruit breeding work. The Fruit Farm offers excellent facilities for the pursuit and correlation of both lines of work.

The work in all of the divisions is hampered by lack of a sufficient number of men who can give the major portion of their time to research. While commendable progress has been made in correcting this difficulty during the year, there is still much need for further segregation of College, Station, and Extension work.

#### MORE LAND REQUIRED

In my last report, I called attention to the need of more land. The details of the present use of the land were there presented and need not be repeated here. The plant breeding nursery work, the various rotations and investigations connected with field crops, require the renting of about 170 acres in addition to the 419 acres now in the farm.

#### NEW BUILDINGS

The addition to the Dairy Barn, consisting of two wings for cows and special weighing and milk rooms and silo, was completed during the year. The new barn for work horses was also completed and work was started on the Agricultural Engineering laboratory.

The need for enlarged greenhouse facilities was presented in my last report and is urgent. The market gardeners and florists are demanding assistance which can be rendered only if greenhouse space is available.

Quite extensive changes and improvements in barns and other buildings were completed at both Morris and Crookston.

Never before in the history of agricultural development has there been such a demand as at present for the results of scientific research in agriculture. Everywhere farmers are demanding assistance in reorganizing their farm practice and systems of management with a view to conservation of soil, elimination of losses due to disease, insects, weeds, improper cultural methods, and crops and animals not adjusted to

limiting factors of environment such as temperature and moisture fluctuation, soil type, markets, etc. This is especially true in the northern half of Minnesota where agricultural development is just starting and where little definite knowledge of the exact conditions is available. Fitting the knowledge we already possess to local conditions, is also a field in which the investigator must co-operate closely with the extension worker.

Puzzling problems arise on nearly every farm that require expert laboratory study. The Extension worker looks to the Station for help in such emergencies. The Experiment Stations occupy the same relation to agriculture as various laboratory and other experts employed by great corporations occupy to them. The scientific development and control of every large and complicated industrial enterprise absolutely depends upon constant and efficient investigation and research. The Stations must be equipped to solve agricultural problems and perform scientific service to agriculture promptly and accurately. The pressing, and at present paramount, need of extension and demonstration work must not lead us to neglect the root of the whole matter, *Research*.

#### SOIL AND AGRICULTURAL SURVEY

In establishing permanent types of agriculture, a knowledge of the soil and climatic factors is fundamental. In some areas climatic and soil conditions will favor forestry, in others fruit growing or farming and stock growing. The development of specialized agriculture which must take place from now on requires community instead of individual development. Co-operative buying and selling, co-operative credit associations, co-operative use of expensive tools, and supervision can be secured only through community development. A careful soil and agricultural survey should be made of the whole State, followed by economic and social surveys, as a basis for such development and community reorganization. The National Bureau of Soils is ready to co-operate with the Station and pay half of the expense of a soil survey.

#### BREEDING HARDY FRUITS

Few people realize that Minnesota has great possibilities as a fruit state. Many of the small fruits like strawberries and raspberries reach their highest perfection here. The Wealthy apple, famed for its quality and beauty, was produced on the old University Fruit Farm at Minnetonka by Peter Gideon, the first horticulturist of the Station. Since that time many other varieties have been developed by the enthusiastic members of the Minnesota Horticultural Society. The new University Fruit Farm at Zumbra Heights is an ideal location for breeding work

and much progress has already been made in breeding plums, strawberries, raspberries, and grapes. Special attention is also being given to apples. For the most rapid progress, two methods of procedure are necessary: first, what may be called the Burbank methods, viz., the use of large numbers (hundreds of thousands), the selection of the individuals coming nearest to the ideal desired and the continuation of this process until the ideal desired is reached and fixed. This is usually the quickest way to secure practical results.

The other system is the one generally adopted by animal breeders, of combining the qualities of several sorts, then crossing. This involves careful scientific control, precluding the use of large numbers as a rule. The latter method gives opportunity to determine the laws of variation and heredity, the elucidation of which will give us far more perfect control of our fruit and crop plants. The first system requires a large acreage on which to carry on the preliminary testing. We need at least forty acres more at Zumbra Heights to test properly the material we now have in sight. This should be leased on a long term basis, or bought as soon as possible. Additional greenhouse space is also badly needed at the Fruit Farm.

#### MARKET GARDENING AND FLORICULTURE

In this northern country, with a short growing season, market gardening especially with the aid of glass should be more extensively practiced. The high quality of vegetables produced here is attracting capital and skilled market gardeners to this industry. Minnesota head lettuce, sweet corn, tomatoes, celery, and potatoes are becoming famous. The canning industry is developing rapidly. This intensive work requires the strictest control of soil, diseases, varieties, and cultural methods. The Station is under obligation to give help in these directions. Greenhouse equipment and men skilled in these lines are necessary.

#### FERTILIZER CONTROL

In intensive horticultural work, when maximum yields per square foot must be secured, recourse must be had to organic manures and to so-called chemical fertilizers. Every state where these are extensively used, has a fertilizer control law, which requires the Experiment Station to analyze all fertilizers offered for sale in the state and report their composition and value. Such a law should be enacted in Minnesota. The time is not far distant when more intensive methods will require the addition of phosphates at least to the organic manures used in general farming. That point has already doubtless been reached in some places. In general farming, however, the first step

should be to develop good systems of rotation in connection with stock raising, the second, to supplement the organic manures as may prove necessary.

#### PURE SEED LAW

Immense loss has come to the farmers of Minnesota and to the State at large through the introduction of such weeds as quack grass, Canada thistle, and hundreds of other such weed pests. We need a seed control law that will enable us to prevent the shipment of seed containing dangerous weed seeds into the State. We should also be in a position to protect the farmer and market gardener as to vitality and trueness to name of the seed he buys. Minnesota is now the dumping ground for seed that cannot be sold in states having good seed laws. This condition should be corrected immediately. Authority should be given the Experiment Station to secure seeds in the open market, test and publish reports upon the tests, stating the names of persons from whom the seeds were purchased, the amount and kind of weed seed, vitality, and any other facts deemed desirable.

#### INVESTIGATION IN ANIMAL PATHOLOGY

Through the effective work of the Minnesota Live Stock Sanitary Board, this State is as free from serious diseases of live stock as any of the important live stock states. There are however, many new diseases appearing from time to time, which require investigation. These the Experiment Station should be ready to handle. The Live Stock Sanitary Board is essentially a police organization to enforce live stock sanitary laws, to keep in touch with the stock interests, and protect them against disease. The Board must have at its command, laboratories and thoroughly qualified experts to carry on research work and assist in diagnosing outbreaks. The Experiment Station should co-operate by furnishing this assistance. A co-operative agreement with this in view is now in force. The facilities possessed by the Station for this work are not adequate. The pathological laboratory and barns and paddocks must be isolated from the rest of the Station buildings and stock, and at least two men in addition to those we now have must give their whole time to this work.

#### MORE LAND NEEDED

It is highly important that the different branches of station work be adequately supplied with land. The crop nursing and breeding work, the various rotations and field experiments, the pastures needed for research in animal feeding, farm management systems, and cultural

practice, require more land. Every year the land available for enlargement of the present farm is increasing in value. We now have in farm and campus 417.15 acres and rent 123.65 acres. We need about 250 acres in addition to what we now own.

#### ENLARGED LABORATORY FACILITIES

There is great and immediate need for more laboratory room. Our seed laboratory and plant pathology laboratory are crowded into space not at all adapted for their work and this is true also of the soil and chemical laboratories. The agronomy laboratories are also inadequate. The new engineering building will give excellent facilities to that Division but little relief to the others. It is hoped that a building for soils, agronomy, and plant pathology may be secured at an early date.

#### RESEARCH IN AGRICULTURAL ECONOMICS

A new bureau has been created to investigate economic problems bearing directly on agriculture. It will take up co-operative organizations, marketing methods, agricultural credit, and similar questions, striving to find means of bettering conditions that are now unsatisfactory. This side of agriculture has until the present been largely neglected. Improved methods of production must be accompanied by better methods of marketing and better business methods.

#### DIVISION OF DAIRY AND ANIMAL HUSBANDRY

In this Division little progress has recently been made in experimental work, except in animal nutrition, because of numerous changes in the personnel of the staff and the difficulty in filling vacancies with men qualified for the work. The pressure of Extension and teaching work has also been a factor.

#### ANIMAL HUSBANDRY SECTION

Owing to the reorganization of the Animal Husbandry Section, but little investigational work has been undertaken during the year. Plans are now being made, however, to inaugurate a series of comprehensive experiments to determine what types and breeds of cattle, sheep, and swine will produce beef, mutton, and pork with the greatest economy and with the largest profits under Minnesota conditions. Individual



records are to be kept of the feed consumed and gains made by the various animals in the herds and flocks, that rations available in Minnesota may be compared as to their efficiency. Considerable emphasis will be given to the use of silage for meat production and to the value of alfalfa when used as a part of the ration.

During the summer of 1912 an experiment was made with dry brood sows to furnish data on (1) the value of pasture as compared with grain fed in the dry lot, and (2) the relative value of several different kinds of pastures which grow in Minnesota. These experiments show that by the use of pasture dry brood sows can be kept in excellent condition for breeding purposes without grain for a period of three months after the pigs are weaned and that one acre of good pasture will take the place of grain to the value of \$25.00. These experiments show further that some kinds of pasture are much more valuable than others for this purpose.

Data were also secured on the value of pasture supplemented with grain as compared with dry-lot feeding for pigs. These results indicate that a much more rapid growth can be secured with pasture and a sufficient saving of grain results to increase materially the profit from feeding.

An experiment is also under way to show that a ration consisting of corn alone for fattening hogs gives smaller gains and less profit than rations which contain some protein food used in connection with corn. These experiments also show the relative value of wheat shorts, linseed meal, tankage, and alfalfa hay as supplemental protein foods. All may be had by Minnesota farmers.

A well-equipped meat shop with facilities for making slaughter tests will add much to the value of these experiments by determining the influence of the rations on the quality of the meat as well as the quantity produced.

#### ANIMAL NUTRITION SECTION

In this section commendable progress has been made in the prosecution of the work, as the chemists employed are not engaged in any class work. Group V of steers, sixty in number at the beginning, were fed until they were two years old and weighed 1,200 pounds on an average. Half were kept on continuous stall feeding, and brought \$99.00 per head, in the South St. Paul market. The other half were turned to a rented pasture as yearlings, and fed the winter following in an open yard, were marketed at the same time and brought \$87.00 per head. The data secured from the group that was turned to pasture are now being arranged for a bulletin in which the commercial phase of the experiment will be presented.

The data obtained from the group under continuous stall feeding from birth to block will be used in nutrition investigation. A complete record has been kept of all feed consumed from birth to block, the composition of the feed, and the composition of the steers at each stage when 100 pounds of growth had been secured, to determine the units of nitrogenous material in the feed required to secure a unit of nitrogenous tissue in the body, and the same of non-nitrogenous material in the feed and that fixed in the body of the steer.

During the biennial period ended June 30, 1912, twenty steers, ranging in weight from 200 to 1,500 pounds, were slaughtered for complete analyses. During the same period the analysts have submitted complete analyses of eighteen steers ranging in weight from 65 pounds to 1,000 pounds. A complete record was kept of the feed consumed by each of the steers from birth to time of slaughter, and its composition as determined by chemical analyses.

Considerable work has been done in supervising the feeding and management of dairy herds in various parts of the State, making monthly visits weighing and testing the milk of each cow in the herds, and keeping a record of the yearly production. The suggestions given in feeding and care of dairy cows has proved very helpful to dairymen throughout the State. During the year Minnesota creamery butter has won two champion trophies, one at the International Dairy Show at Milwaukee, and one at the National Dairy Show at Chicago, and has now won nine out of the eleven grand prizes offered in interstate contests.

A full and complete record of feed consumed and dairy products yielded by the Station dairy herd has been kept, and during stall feeding chemical analyses of all feeds were made. The data obtained will be used in further studies in Animal Nutrition. One winter's preliminary feeding has been carried on in comparing roots with grain, for milk production.

#### POULTRY SECTION

The Poultry Section has been organized and buildings and grounds are being planned for its use. A system of records is being perfected and plans are being made for effective work in investigation, education, and the dissemination of valuable and practical information on poultry husbandry.

#### VETERINARY DIVISION

There have been appearances of several infectious diseases among University Farm stock during the past year, though the losses have not

been heavy. They were as follows: *haemorrhagic septicaemia*, loss of one cow; *rabies*, ten sheep and two hogs; *hog cholera*, sixteen small pigs and shoats; *lymph-adenitis*, one sheep; *infectious abortion*, a few calves. Considering the number and variety of our University Farm stock and the unusual exposures which stock must undergo when kept at an institution like this, this loss should be considered very light. There has been about the usual number of minor cases of illness and lameness.

*Hog Cholera Work.*—This work has been continued chiefly in three lines: (1) serum production, (2) field work (educational), and (3) efforts to develop a simpler and less expensive method of immunization.

There has been a rather serious prevalence of cholera in several portions of the State. We have had a heavy call for serum and believe our serum plant has saved in hogs this one season several times its cost to the State. We have been able to reduce the price from two and one-half cents to two cents per cc. which considerably lowers cost for owners.

Losses under treatment with our serum in infected herds have averaged only about 20 per cent, i. e., owners of infected herds have saved about 80 per cent of their hogs. The average loss in sound herds when treated by the double, i. e., serum and virus method, has averaged 2.43 per cent, which is probably about as low as we can reasonably expect. Other state institutions report a loss in this same work ranging from 2.25 per cent to 3.2 per cent.

Demonstrations of treatment accompanied by talks on hog cholera and hog cholera serum have been conducted in various portions of the State, usually in co-operation with the high school agriculturist.

It is the general plan to make our serum-production work self-supporting from sales of serum, at a slight advance over cost. Our new method of immunizing (V. B. vaccine) continues to appear encouraging. During the past year our work has been confined to field trials on a much larger scale than heretofore. Later experience continues to confirm our original discovery and previous statements that very young pigs from immune sows are, as a rule, highly immune at birth and continue so for approximately five weeks. During this period they seem able to receive without harm direct inoculation with unmitigated virus, the cost of which is practically nothing. The most important point in this connection upon which we are endeavoring to gather information is the duration of immunity so conferred and the possible need of a second treatment when the pigs have partially matured.

*Ventilation.*—Work with six steers has been in progress along the lines followed during the two years previous. Early findings in this work were so contrary to expectations and generally accepted

opinions concerning the effects of poor ventilation that further verifications of results seemed desirable. This later work has fully demonstrated the accuracy of the first work, and may be regarded as finished so far as blood cells and urine are concerned. During the coming year no further work will be done with blood. Our work will be devoted mainly to a study of disease resistance as affected by lack of ventilation, using the bactericidal power of serum and the opsonic capacity of leucocytes as indices. Work along these lines just completed indicates that valuable new data will result from this work, when thus carried out on an extensive scale.

Results of the work carried on during the past year verify previous statements to the effect that it is practically impossible by ordinary respiratory processes to reduce the available oxygen in the most poorly ventilated farm stable so that there is an insufficient supply for ordinary needs. It is equally impossible for carbon dioxide to accumulate to such degree that it becomes harmful in the ordinary farm stable. Work already done indicates that poor ventilation may exert a marked harmful effect by lowering disease resistance. Important improvements have been made in the laboratory during the year, which will greatly facilitate our work.

*Swamp Fever.*—Co-operative work in the study of swamp fever has been continued with the United States Department of Agriculture and Minnesota Live Stock Sanitary Board on the same basis as heretofore. There have been no important changes in policy, problems, or results. The most important problem now appears to be that of positive diagnosis. Work during the past year has been chiefly along this line.

*Work Planned for 1912-1913.*—Some work during the coming year will be directed to the study of disease resistance as affected by lack of ventilation. Work will be continued in certain lines in the study of urine of confined animals and of animals in free air, the urine being studied as an indicator of metabolism.

We propose to continue the production of serum and to study conditions affecting the potency, more economical production, and the causes of occasional disappointments. Our endeavor to perfect a simpler and less expensive method of immunization will be continued on the same lines as heretofore. Original (V. B.) vaccination will be given extensive field trials with a special view to studying its range of usefulness.

Emphasis will probably continue to be placed upon the difficult problem of the diagnosis of swamp fever.

*Needs.*—The need is constantly growing more apparent for a small veterinary pathology farm equipped with suitable buildings for work with infectious diseases and apart from the college campus.

## DIVISION OF AGRONOMY AND FARM MANAGEMENT

Investigation has been conducted along six main lines during the current year: (1) plant breeding, (2) farm crops, (3) crop rotation, (4) the cost of producing Minnesota farm products, (5) weed eradication, and (6) farm management.

*Plant Breeding.*—The plant breeding work has been carried out under the various subprojects as outlined in the annual report for 1911, numbering fourteen in all. The work outlined under many of these subprojects is permanent in nature and will need to be continued indefinitely. The winter wheat and rye breeding has given good results this year. Good growth has been made and a good crop harvested. No effort has been made to introduce further new varieties of rye or winter wheat, but the search is being continued for hardier and better strains. The spring grain nursery started in good season this spring, but was seriously injured by a severe hail storm on July 12. On this account the yields will probably not be fully reliable. The stocks will be carried over and the work continued next year. Barley breeding is being conducted in co-operation with the Bureau of Plant Industry, United States Department of Agriculture. New strains are giving promise of excelling Minnesota No. 105. Alfalfa and clover breeding are being carried forward and some progress has been made in securing hardy stocks of alfalfa. Timothy and bromus selections are being made. A strain of bromus selected from the nursery in 1908 gives much promise of desired and stable characters in this crop. Six newly selected stocks of timothy are being tested in variety plots.

The corn-breeding stations have been continued and are proving very useful in the matter of adapting corn varieties to certain localities. The demand for the No. 13 and No. 23 corn continues to grow, and these varieties are becoming popular in many parts of the State. The State Board of Immigration made a corn display in 1911 at the State Fair for which they called for the best representative corn from the various counties. Thirty-three out of the eighty-five counties sent in Minnesota No. 13, seventeen sent in Minnesota No. 23. These figures go to show that the two varieties are adapted to, and being used over, a large area of the State. No new varieties have been distributed this year. A large number of varieties and strains of spring wheat, oats, barley, and flax are being grown on increase plats and will in time be offered for distribution.

*Farm Crops.*—The tests of varieties and of methods of growing farm crops were also interrupted by the hail. Barley was completely destroyed. It was estimated that the oats and wheat would yield a one-half and one-third crop respectively. The data for this year are not

reliable and the stocks of 1911 seed will be carried over for the tests in 1913. Tobacco growing has been continued in Sherburne County and in a few other localities in the State. Forty farmers are growing a total of about one hundred acres this year in Sherburne County and vicinity. Interest in the industry is growing in these localities, and the quality of crop this year is better than before. Seed selection is being made to meet the increasing demand for Minnesota grown seed. Thus far the crops have proved equal in quality to the Wisconsin crop in every detail. A small acreage has been seeded to Bokhara with a view to learning its value as a forage crop. Other studies of forage crops have also been taken up during the year and will be continued in co-operation with the Division of Dairy and Animal Husbandry.

*Crop Rotation.*—The Field C and Field T rotation crops mentioned in earlier reports have been cropped in the regular manner this year, and results from these two projects are quite satisfactory. Samples of the soil have been taken and the manures applied to the field as the crops were taken from it have been sampled for analysis. The work can be made much more effective as soon as arrangements are made for the prompt analysis of the soil, manure, and crop samples. The Field T rotations were not laid out as soil studies, but by analyzing the soil occasionally, if not yearly, we can learn much concerning the value of the different methods of handling the soil, and we should not lose the opportunity.

*Cost of Production.*—The cost of production studies have been continued on the Northfield and Halstad routes. In addition, we have a few individual farmers who are co-operating with us in securing cost data. In the spring of 1912 we also made arrangements to secure data concerning the cost of growing tomatoes, cabbage, and a few other crops. The data regarding the cost of these crops are being secured from vegetable growers adjacent to University Farm.

*Weed Eradication.*—The studies in quack grass eradication at Monticello are going forward very satisfactorily. The forty-acre farm rented at that point is practically free from quack grass now except on a small portion of the land which has not yet come under rotation. In addition to the quack grass eradication work, we have this year undertaken in co-operation with farmers the eradication of Canada and sow thistles. This work is being done at Gentilly, Polk County, Minnesota. The spraying solutions tried last year in eradicating quack grass and Canada thistle did not prove satisfactory and no further trials have been made.

*Farm Management.*—Only a little work in farm management has been undertaken during the present year, owing to lack of time to supervise such work. The calls for aid in farm organization are frequent, and so far as the time of the workers in the Division will allow, aid is

given. Problems in farm organization are being studied and applied to farms wherever conditions are known. This work is carried on necessarily in co-operation with farmers in various parts of the State, and seems to be the only manner in which studies can be made. The George Olson farm at Belle Plaine and the Meadowlands farm at Meadowlands are still being supervised by this Division, though they cannot strictly be said to be under investigation. The demonstration farm work has been transferred to the Extension Division, the Division of Agronomy and Farm Management reserving the investigational work. The farm equipment work secured valuable data from fifty farms last year. Preliminary data have been secured from a number of other farms. The work will be continued this year. In addition to the farm equipment work, a new project was started in June with a view to securing a survey of all of the farms of Northfield Township. The field data have been gathered and are ready for compilation. Additional farms will be surveyed during the year in the same locality. It is proposed to get data on from 600 to 1,000 farms in the vicinity of Northfield, which can be classified and compiled in such a manner as to reveal the profits from the various types of farming followed.

*Future Development.*—More assistance in experimental work is one of the serious needs of the Division. We need one or two plant breeding experts, and there is need of bacterial studies in connection with the crop rotation work. Soil bacteriology is an important feature in securing large production and the continually cropped plats offer a good field of study. Bacterial influences are adversely affecting the crops and we should know the effect of the various rotations as related to bacterial growth. Additional clerical help is needed and a draftsman should be employed on the farm survey and farm management work. It is hoped that at least a part of this additional help may be granted in the near future.

## DIVISION OF ENTOMOLOGY

The occurrences of greatest interest to entomologists during the period from July 1, 1911, to June 30, 1912, may be briefly suggested as follows:

- (a) Marked injury by cut worms of various species during May and June.
- (b) Very severe injury locally by grasshoppers during June, July and August.
- (c) Accompanying grasshopper injuries and resulting from the abundance of grasshoppers, depredations by one or more different species of blister beetles have been extremely marked.

- (d) There was very much complaint of insects on shade trees throughout the State, but we find that in addition to insects causing the loss of valuable shade trees, fungous diseases are playing a very important part.
- (e) There have been the usual complaints regarding different scale insects, Buffalo tree hoppers, plant lice, household insects, and insects affecting field crops and market gardens.

*Grasshoppers.*—Four men have been in the field during the summer of 1911, and the work has progressed so favorably that we are able to offer the farmers a poison spray which is an efficient, practical, and economical method for protecting a field from the ravages of this pest. It is to be noted that the success of this work depends entirely upon the farmer. If he delays in this application too long, the method will not bring the best results. Properly applied in time it is most efficient. This spray is arsenite of soda. We are preparing a number of biological notes upon the life history of different insect parasites, habitat, food habits, etc. About 9,000 large posters giving the result of our work and methods of control of grasshoppers have been sent broadcast over the State in grasshopper sections.

*Adams Fund Research.*—Decided progress has been made in the work against the clover seed chalcis and facts new to science have been brought out as the result of the year's work. We hope to close this project before very long. To the Adams Fund Project has been added also the investigation of the larch sawfly, an insect destroying tamaracks in the northern part of the State.

*Orchard Spraying.*—Experiments at the Station and co-operative experiments along the line of economic spraying for orchard pests have been carried on with good results, and investigations in the life history of the plum curculio will probably settle some points more or less under controversy.

*Shade Tree Pests.*—As a result of two seasons of drouth, shade trees have succumbed to the attack of insects and fungous diseases. We have made a special study of this phase of work and are doing all we can to meet the emergency. It is to be noted, however, that fungous diseases are playing almost or quite as great a part in the destruction of these trees as insects. The life history of the elm twig-girdler is being studied in this connection.

*Corn Billbug.*—The corn billbug is becoming more or less prominent in this State. Its life history and method of control are under investigation.

*House or Typhoid Fly.*—A vigorous campaign has been conducted against the typhoid fly. In co-operation with the State Board of Health we have sent out about 13,000 circulars, which have been posted in prominent places throughout the State. These circulars show the



dangers of tolerating the presence of the house fly and suggest methods of control. In co-operation with the Division of Agricultural Engineering we have offered to the public what we call the Minnesota Fly Trap. It bids fair to be a useful invention for the citizens of Minnesota.

*Insectary.*—A large number of experiments along the line of life history of insect parasites have been conducted in our insectary.

*Nursery Inspection.*—About sixty nurseries have been inspected and \$236.25, received for nursery inspection, has been deposited with the State Treasurer to be added to the fund for combating injurious insects. All foreign stock imported into this State from Holland, Belgium, or France has also been inspected by this Division.

The Station Entomologist also holds the position of State Entomologist. In this capacity he has published Circular 22, A New Method of Combating the House Fly, Circular 23, Household Insects—Mosquitoes, Ants, "Silver Fish," Crickets, and a periodical called Insect Life, issued on the first of April, May, June, July and August.

## DIVISION OF PLANT PATHOLOGY AND BOTANY

*Disease Survey.*—The disease survey has been made as in previous years. Many inquiries by farmers and fruit growers have been answered, and whenever necessary and practicable, personal visits have been made. In spite of the wide circulation of bulletins, giving information concerning fruit and garden truck diseases, these diseases have been increasing in number and severity. At least two very serious cankers of apples have been recently imported on nursery stock from other states and new diseases on other crops have been reported.

*Rusts of Cereals.*—The Adams Fund work on the nature of rust-resistance has yielded promising preliminary results. The work on breeding and selecting wheats with a view to obtaining rust-immune varieties has progressed very satisfactorily. Varieties with resistant characters have been developed and are now being tested for other characters. The work of the development of varieties is being continued. A number of resistant and susceptible varieties have been used in experiments to determine the effect of external and internal conditions on infection and an attempt has been made to correlate ecological and physiological factors with the various phenomena of infection, development of mycelium in the host, formation of pustules and general effect of the parasite on the host. Results have also been obtained on various phases of the biological race question and on the rejuvenation through the acidium theory.

*Diseases of Cereals and Forage Crops.*—The cereal work has been confined more particularly to the testing of flax varieties for wilt- and rust-resistance. There are indications that some of the Minnesota varieties are notably resistant to the rust. Selections have been made and these, together with other varieties, will be tested again next year.

Corn smut has become so serious as to require special attention. The commonly accepted explanation of the life history of the causal fungus and the preventive measures ordinarily prescribed seem insufficient to explain many of the phenomena connected with its occurrence and control. This year data have been obtained on a large number of varieties and experimental work has been begun in an attempt to determine accurately the life history of the fungus and the etiology of the disease, in order that more effective methods of control may be prescribed.

*Diseases of Truck Crops, Ornamental Plants, and Mushrooms.*—The most pressing need along this line is to get information concerning potato diseases before the growers. Numerous articles have been published in an attempt to acquaint farmers with the fact that present methods of growing potatoes are sure to be followed by disastrous results. A popular bulletin is in process of preparation which will be sent out in the hope that all growers may be warned of the danger of permitting diseases to accumulate. Experimentally, work is being done to determine the comparative efficiency of various sprays in checking early blight and *Cercospora* leaf spot of potatoes.

A large number of varieties of beans have been tested in order to determine their relative susceptibility to bacteriosis. Promising results have been obtained, but they are not yet absolutely conclusive. The work will be continued another year. The effect of spraying has been noted on bacteriosis as well as on other bean diseases.

Work on the cucumber "nubbin" has been continued, though no final solution of the problem has been reached.

The investigation of mushroom diseases was the subject of investigation by an advanced student during the past year. The etiology of bacteriosis was well worked out, only a few straggling questions remaining for solution.

*Fruit Diseases.*—A serious fruit spot of Wealthy apples and the brown rot of plums have both been investigated. The work on the apple spot is nearing completion, while valuable information has been obtained in the brown rot investigation. Spraying tests indicate that three sprayings reduce very considerably the loss from brown rot, while four will probably reduce it to a minimum. Although all the data are not yet available, it is very probable that definite recommendations may now be made for spraying under Minnesota conditions for the control of the apple and plum diseases prevalent at the present time.

*Seed Laboratory.*—The Seed Laboratory has made approximately one thousand weed and weed-seed determinations for farmers, instructors in high schools, rural schools, and others. Seed tests of over fifteen hundred samples of grains and clovers for both purity and germination have been made. The problem of hard seeds in clovers and alfalfas has been investigated with some promising preliminary results and considerable work on the Minnesota Weed Series of bulletins has been done.

Considerable work in extension lines has been accomplished including collections of Minnesota grasses for demonstration purposes, honey plant collections in co-operation with the Bee Keepers' Association, and collections of weeds and weed seeds for Seed Laboratory purposes.

Six hundred and forty weed-seed cases have been distributed, mainly within the last year.

#### DIVISION OF AGRICULTURAL ENGINEERING

Plans and surveys were made for the drainage of a farm in the vicinity of Faribault. The land was a low valley between higher lands with abrupt slopes, a great deal of damage being done in the valley by water seeping from the higher lands near the foot of the slopes. The proposed system included 4.8 miles of tile varying in size from 4 inches to 18 inches in diameter. The construction of this system has been under way during the entire year and will be completed at an early date. Surveys and plans were furnished by this office and the foreman on construction reported to this office, but the foreman's salary and all expenses of construction have been paid by the land owners.

On account of the excessive rains of 1911 no practical information was obtained with regard to the value of irrigation. The experiment on this subject was begun in 1911 in co-operation with irrigation investigations of the Office of Experiment Stations, United States Department of Agriculture and the Division of Plant Pathology and Botany of this Station.

So far as practicable, experimental work has been carried on for the purpose of determining the best methods of testing drain tile. These tests include the actual strength of standard makes of tile, amount of moisture in tile, and effect of freezing on tile. Some work has also been done to determine the effect on cost per cubic yard of tile trenching with increasing depth and width of drains.

A small experiment to determine the effect of drainage on root

growth was carried on in 1911 with fairly good results. This experiment is under way at the present time and the final results are not yet available.

During the coming year it is expected to continue testing tile, complete a report, and assemble the data collected on methods of tile drainage construction.

## DIVISION OF AGRICULTURAL CHEMISTRY AND SOILS

This has been the most satisfactory year's work in the past three years. There have been no resignations, and this continuity of work has resulted in the publication of two bulletins and the submission of a third for publication during the past year, with projects for material for additional publications next year.

Industrial alcohol has been the subject of investigation at the experimental distillery. The distillery has a capacity of 60 gallons of 90 per cent alcohol per day, and has been operated a large part of the year with a production of 1726 gallons of 90 per cent alcohol. The results obtained show that a plant of this size is too small for profitable operation, and data are being collected to determine whether a plant of larger capacity could be profitably operated in this State. This work will be completed during the coming year. A study of the relative lighting efficiency of alcohol and kerosene has been completed, with publication of results as Bulletin 126 of this Station. Work on the composition of Minnesota potatoes and changes in composition during growth, has been completed.

The work on cereals and flour consists in general of the operation of an experimental flour mill and baking laboratory, control work being done for the State Board of Grain Appeals and State Board of Control. In all, 93 samples of wheat have been milled and the flour baked and analyzed. Fifty-one samples of flax have been analyzed for the Board of Grain Appeals and 105 samples of flour have been analyzed and baked for the Board of Control.

In addition to this control work, a wheat survey of the State has been started, and a report of the first year's work has been submitted for publication. The work will be extended and continued from year to year. The idea is to get at the milling and baking value of wheats raised in various sections of the State and to study causes affecting their value.

A study of methods of increasing the protein content of oats has been the purpose of nitrogen determinations on 24 samples of oats, in

a co-operative experiment with the Division of Agronomy and Farm Management.

Soil fertility work done on the Adams Fund consists largely of a study of the soils and crops from 44 rotation plats on Field C at this Station. All crops removed and fertilizers applied are analyzed for plant food content. A study of the humus from typical plats of this field has been completed, and the results published as Bulletin 128 of this Station. The work for this coming year will be largely routine analyses of crops and fertilizers.

Soil surveys have been made of 17 demonstration farms, having a total area of 2,843 acres, and 751 samples taken. Chemical work has been completed on soils from 10 farms, and pot cultures have been run on soils from 9 farms. Eight farms that remain will be surveyed this fall. The entire work will probably be completed during the coming year, except field trials where a deficiency of plant food is indicated. Preliminary work looking toward a Reconnaissance Soil Survey of the northeastern section of the State has been completed, and an appropriation for such a survey, in co-operation with the United States Bureau of Soils, will probably be asked for at the next session of the Legislature.

Peaty soils have been studied in co-operation with the Divisions of Agronomy and Farm Management, Agricultural Engineering, and Plant Pathology and Botany. The work consists of a study of the composition, fertilizer needs and general crop adaptation of the peaty soils of the State. A large number of peaty soil samples have been collected and analyzed, and pot cultures and field fertilizer tests have been carried on for two years. Data for a preliminary report will be ready this fall. Work on the recently drained peaty tract at the North Central Experiment Station, Grand Rapids, has given but few results, owing to the wet condition of the land.

The effect of local conditions upon the composition and milling value of the important varieties of wheat grown in various sections of the State, over a period of years, has been studied in co-operation with the Division of Agronomy and Farm Management. Next year the number of varieties and places where grown will be increased.

Commercial feeds have been under investigation, in co-operation with the State Dairy and Food Department. This work includes the determination of composition and possible adulteration of commercial feeds on the Minnesota market. Chemical determinations have been completed on 165 samples, representing 22 classes of feeds. A microscopic examination of the samples remains to be made, when the results can be prepared for publication.

An exact knowledge of the factors determining the strength of flour is perhaps the thing most needed in the solution of problems in

wheat and flour chemistry. Typical samples of wheat from Illinois, Kansas, Montana and Wisconsin have been collected and milled for the study of this problem.

The sorghum sirup industry is at present of little importance in this State, but it is capable of great development. The sirup now produced is practically all marketed locally and does not enter general trade channels. There is a wide demand for this class of sirup in this and adjoining states which is now supplied with glucose mixtures. The purpose of this investigation is to study present conditions of the industry, conduct experiments in growing sorghum and in the manufacture of sirup, and to use all possible means to help place the sorghum sirup industry on a sound and scientific basis.

Conditions affecting the value of silicate of soda, or water glass, as an egg preservative, are being studied.

Soil work done includes a study of the absorptive and adsorptive properties of soil.

In addition to the work outlined, a considerable number of samples have been analyzed for the Agricultural Division, consisting of sugar beets, mangels, and legumes, and a large number of moisture determinations have been made on fodder samples. Considerable request work has been done for farmers, consisting largely of examination of samples of soil, water, commercial feeds, formaldehyde, and other materials submitted.

We plan to continue the work just outlined in the Division of Agricultural Chemistry and Soils, without immediate prospect of taking up new lines.

The use and sale of commercial fertilizers in this State are increasing, and an adequate law should be enacted providing for the inspecting and labeling of them. Such a bill was introduced at the last session of the Legislature but failed to pass.

A greenhouse is badly needed for carrying on soil studies, both with students and in Experiment Station work.

## DIVISION OF HORTICULTURE

The past season has been good for horticultural crops as a whole. Apples, among the trees fruits, bore lightly, although Anisim, Hiberna, Duchess and Wealthy, and among the crabs, Florence and Shields, bore a fair crop. Plums have been especially good. Our block of 3,000 seedlings fruited for the second time this year. Among them are some very good trees. The inferior stock will be taken out and destroyed

this fall, giving room for the better trees. Grapes were a fair crop, but very few varieties were heavily loaded. Highbush cranberries bore well and there was an increased demand for the fruit. This is a plant which is useful, both as an ornamental and as a fruit and ought to be planted much more frequently than it is.

Another ornamental proving especially valuable this year was *Cotoneaster acutifolia*, useful either as a hedge or as a clump plant. The sandthorn has also been attractive on account of its berries. The mayday tree, among the early flowering trees, deserves especial notice and the Japanese lilac, among the later flowering shrubs.

Tests of ornamentals have been continued this year as in past seasons and it is hoped that further tests of desirable varieties may be made next season of both herbaceous ornamentals and shrubs.

*Potato Work.*—The testing of varieties of potatoes has been continued as usual. In addition to the usual test these varieties have been observed for similarity of type and habit, as a result of which groups have been evolved which include most of the commercial varieties found to be of any importance in Minnesota.

The studies pertaining to asexual inheritance were very much enlarged the past year. The susceptibility of different groups to degeneration was one of the lines of study and has been fairly well determined for the conditions at the Station. Last year some very striking results were obtained which showed that there is a relation between shape of tuber and degeneration. These results showed how the most vigorous potatoes can be selected for "seed" and the degenerate tubers avoided, thereby aiding in overcoming degeneration. Experimental work was carried on last year in an effort to determine the relation of environmental factors to degeneration and how to overcome or take advantage of them.

The effects of different soils and fertilizers on degeneration were studied last year. This was continued and enlarged to include some other factors this year and will be still further enlarged in the future as help and facilities permit. Some results were secured, but much more experimental work is required before any conclusions can be drawn.

Degeneration experiments are also being carried on with small tubers as compared with larger tubers, but the results are not yet conclusive. The effect of digging seed potatoes before they are fully matured on their yielding power is also being studied, the results so far secured being in favor of the practice.

Very extensive work in the selection of the best hills as compared with the selection of the best formed tubers was carried on for three years with the results very decidedly in favor of the selection of the best formed tubers. Last year hills of different sizes and different shaped tubers of the same varieties were planted separately with the

results showing that the largest average production was decidedly in favor of the medium sized hills with well formed tubers.

The production of new varieties has been continued. In the Station tests a number of seedlings having marketable tubers, from the crosses obtained in 1909, produced twice as large a yield as the best standard commercial varieties on the same land. Preparations will be made for the distribution of the best ones in the spring of 1914. Between 25,000 and 30,000 potato seedlings have been grown at the Station since the spring of 1908.

The potato breeding work is greatly hindered by the inability to make the crosses desired. The study of factors affecting the vitality of the flowers of potatoes cannot be carried on in a thorough manner on account of a lack of help.

Spraying experiments for the control of leaf diseases have been continued as in the past. Experiments carried on with the stem end rot of potatoes (*Fusarium*) showed that the yield is reduced even where the infection is comparatively shallow.

Planting studies were carried on with regard to size of seed piece, number of eyes, vigor of eyes from different parts of tubers and distance apart to plant. Different commercial fertilizers and manure, alone and in combination, were tested. One striking result of this work was a great difference between the Early Ohio and Sir Walter Raleigh varieties in their relative response to phosphorus and potassium.

One of the important new lines of work undertaken last spring was co-operative experimental work with the Clay County Potato Growers' Association. Much benefit will undoubtedly result to the growers from this work and it is hoped that it may be extended to other sections in the future.

*Vegetable Work.*—The vegetable work has been along the following lines: testing of varieties, tomato breeding for the value of first generation crosses and production of new varieties and a study of strains of onion seed. A large number of onion varieties were grown and careful notes taken to determine their value.

*Fruit Breeding Farm.*—The season has been especially favorable for work at the Fruit Breeding Farm. A large number of crosses of various fruits were made under glass during the winter. The seeds of some of these crosses were planted and have made a good growth during the past season. Some have been stratified or planted but will make no growth till next season. The selected Beta grape seedlings came through the winter with little injury and have given a good crop of fruit. Plums and plum hybrids set fully as heavy a crop as last year, giving a chance to make a further selection of good trees. The inferior specimens will be removed this fall, leaving several hundred plums of especial merit. A number of plum hybrids (*P. Americana* x *P. triflora*



crosses) came through the winter without the least injury and have fruited heavily this year. Some very promising plums have resulted from these crosses on account of their hardiness, quality and tree characters. Several thousand plants have been budded from the selected varieties of plums, giving stock for further trial and later distribution. The pear seedlings, grown from seed obtained in Manchuria, were killed back to the snow line, giving very little promise of value. A large number of raspberry and strawberry seedlings fruited this spring and the most promising of these have been selected and propagated for further trial. Some of the selections of last year's work have been propagated for distribution in the future. The block of seedling apples has been of especial interest since a number of these fruited this year for the first time. Several varieties of winter apples, topworked on Hiberna and Patten's Greening, have fruited. These are to be used in the crossing work.

*Adams Fund.*—The Adams Fund work has been carried forward along three general lines: a study of the causes of sterility in fruits, hardiness or the lack of hardiness and the inheritance of fruit characters. Emphasis during the past year has been given to the work in sterility. While particular attention has been given to sterility in the grape, material has been collected to extend this phase of the work to the plum and strawberry. A collection of the different species of our native fruits, as well as those introduced from other countries, is being made, with the object of making these the basis of the study of fruit characters. This material will also be used in work on hardiness for comparing one species with another. The crosses already on hand at the fruit farm at Excelsior are being used in this work. A record is being made of the new seedlings which are hardy, as well as those which are not, with the object of determining which are the most desirable combinations to follow up in subsequent breeding.

It is the object of this phase of the work to make a study of the principles underlying the production of new fruits which will meet the growing conditions of Minnesota.

*Needs.*—For the carrying on of the potato work at the Station to the best advantage more land should be obtained. A potato specialist should be engaged to devote all of his time to potato work. A potato and vegetable storage cellar should be constructed to keep potato stock over winter. A larger variety of potato machinery will be desirable. This would necessitate larger and better machinery storage quarters.

*Fruit Farm.*—At least forty acres more land should be obtained while it is available. One of the special needs is a larger maintenance fund, enabling the hiring of more and better help. An addition

to the greenhouse will need to be made to meet the increased needs of this branch of the breeding work.

*Greenhouse.*—At the present time very little, if any, Station work can be carried on in the greenhouse at University Farm as practically the whole space is required for student work. A large addition should be made to the present plant to enable more Station work to be done under glass.

*Vegetable Work.*—For the best results in investigational work with vegetables, at least ten acres of land should be purchased and equipped with proper vegetable forcing houses. This would necessitate the employing of a specialist along vegetable growing lines.

## DIVISION OF FORESTRY

Most of the experimental work of the College of Forestry is now conducted in co-operation with the United States Forest Service at the Cloquet Forest Experiment Station four miles southwest of Cloquet, in Carlton County, Minnesota. W. H. Kenety is in charge of this Station. It occupies 2,640 acres of land, which is covered chiefly by mixed growth of jack pine, Norway pine, white pine, black spruce, balsam fir, tamarack, and white cedar. A great deal of the original forest has been cut over and some parts have been burned by forest fires several times in the past. The present forest presents three types: (1) jack pine, (2) mixed Norway and white pine, and (3) black spruce and tamarack swamp.

This Station represents conditions typical of the pine belt of Minnesota and the Lake States, so that any experiments carried on here will be indicative of what can be done with the national forests, and private and state lands in the forest areas of Michigan, Wisconsin, and Minnesota. Observations are made on precipitation, maximum and minimum temperature of the air, wind velocity, humidity, evaporation, and on the soil moisture and temperature at depths of 6, 12, and 24 inches in each of the three forest types. The observations are made each day throughout the growing season from the latter part of May to November. During the winter the amount of snowfall and the relative thawing and accumulation in each type were measured.

*Seed Collection and Extraction.*—Owing to the increased demand for information in regard to the cost of collecting and extracting pine seed by seed dealers and private individuals interested in this work, a small extraction plant was built at the Station. This was a very simple and cheap affair, but served the purpose for the time being. About

eighty bushels of Norway and jack pine cones were collected and the different degrees of heat necessary to extract them and the optimum temperature for each species determined.

*Germination Tests.*—Owing to the high price of pine seed and the fact that no guarantee of the quality of the seed is given by seed dealers, a water bath oven was obtained in which to carry on germination tests for the various tree seeds. The plans for the future contemplate the erection of a small greenhouse where these tests may be carried on under natural conditions and where seed may be tested for others.

*Nursery.*—One of the main objects is to carry on reforestation studies, both by planting and sowing. Stock for planting must be raised as the prices demanded by nurserymen are exorbitant. Several acres have been cleared and this will be used for a nursery. This year, with good conditions, this nursery will raise from 150,000 to 200,000 young trees.

*Reforestation.*—A great deal of the land in the northern part of the State, and other Lake States, is occupied by jack pine. Experiments were carried on to test the success of underplanting with some species of greater commercial importance. These experiments were so successful that enough stock was ordered to plant fifty acres of such land next spring. The records kept should give a very good idea of the cost and of this method of reforestation.

Another method used was seed-spotting in different areas. This is a cheaper method, and if successful, will also be used extensively.

*Test of Species.*—In order to see what species of conifers were adapted to the Lake States, arrangements were made with the United States Forest Service to furnish this Station with 125 transplants of each of sixteen different species. These species were chosen and set out in October in the hope that they might prove better adapted to the climate and more valuable for this region than some of the native trees. The species obtained were western white pine, Norway spruce, lodgepole pine, Scotch pine, yellow pine, Douglas fir, Engelman spruce, and noble fir. All of this stock was three years old and special care was taken with it. The idea will be to add to this arboretum from year to year. In connection with this, fifty seedlings each of the hardwoods most likely to be adapted to this region were ordered for planting in the spring. The trees which show the best results will be recommended to the people in the northern part of the State for parks, home planting and woodlots. Many species of shrubbery adapted to this region have been selected and planted so that visitors may see what shrubbery is best adapted for planting at their homes and at public places.

*Working Plans.*—In order to prepare a model working plan, an intensive survey was made of the Station. Studies of natural reproduction and thinning investigations upon stands of jack and Norway pine of different ages were carried on.

*Growth, Volume, and Yield Studies.*—Stem analyses were made of cedar, Norway pine and tamarack. At present work is being carried on in determining the mill grades of lumber sawed from trees of different sizes and ages. This work is quite extensive, the object being to determine the quality of lumber sawed from Norway and white pine trees of different ages and sizes. As yet all work as to the length of rotation best suited to Norway and white pine is based upon increment tables. The wide difference existing between the price of lumber of the lower and higher grades is sometimes as much as \$40 or \$50 a thousand feet. The purpose of these tables is to determine at what age Norway and white pine should be cut to get the highest financial returns.

For instance, a tree may have reached its highest increment growth at the age of seventy years, but if left until ninety or one hundred years, the percentage of high-grade lumber in the tree may so increase that the net returns of the tree will be much greater at one hundred years than it would have been if cut at seventy when the maximum growth was reached.

*University Farm Post-Treating Experiments.*—Some posts have been treated for an experimental fence at University Farm, and some co-operative work done with farmers and agricultural high schools. These experiments are to determine the best preservative for fence posts and other farm timbers and the most effective cheap methods of treatment. The work necessarily requires years for very definite results, but some should be available in another year.

## BUREAU OF RESEARCH IN AGRICULTURAL ECONOMICS

By action of the Board of Regents, November, 1911, a Bureau of Research in Agricultural Economics was created. This action took effect February 1, 1912.

*Purpose.*—Because of the peculiarly pressing problem presented by external economics affecting the value of products from the time they leave the farm until they reach the consumer, immediate attention is being devoted to certain aspects of the marketing and distribution of farm products with a view to studying the comparative value of the different agencies performing the function of the middleman. The

situation in different parts of Minnesota is subjected to special inquiry. Data are being gathered bearing on marketing and distribution in other states and in foreign countries so far as such information may be of value in relation to conditions in this State. Separate studies are made for different kinds of farm products, as perishable crops and staple products such as wheat, whose marketing problems are somewhat different. What economic functions must be performed in each case and what mechanism is best adapted to this need is what we shall try to throw light upon as a result of our investigation. In the comparison of various methods employed, attention is devoted to the achievements of various kinds of co-operative effort in this field. By a comparative study of different types of organization, we hope to learn just what sort of co-operative effort may be expected to be successful. We are taking up the problems connected with the distribution and sale of all the important farm products such as fruits, vegetables, milk, butter, eggs, meats, cattle, and hogs, and the leading grains produced in Minnesota.

Another line of inquiry is that of agricultural credit. We are gathering and want to place before the farming communities whatever information is available regarding the various facilities for credit that have been of value in other parts of the world. The problem of securing sufficient capital under favorable conditions is a vital one for the farmer and suggests the need of some kind of associated effort that will enable him to improve his credit.

The Bureau will also investigate certain aspects of the land problem. A study will be made of systems of registering titles to lands, methods of transfer and means of acquiring lands. We shall want to compare the different kinds of relations between landlords and tenants with a view to ascertaining the factors that make for efficiency or inefficiency.

Certain social and political aspects of the rural problem will also be considered. The different forms of community life, the tendency towards absentee landlordism and the migratory movement between rural and urban communities will be given attention. In this way it is planned to make the Bureau a center for intelligent study along many lines of interest to the people of the State. Finally, it is planned to disseminate this information through the publication of bulletins showing the results of our investigation.

*Projects Undertaken.*—The work of the Bureau has thus far been listed under three projects:

1. General Information, Agricultural Economics.—The object is to gather data that will enable the Bureau to serve as a clearing house of information regarding rural co-operative organizations, land ownership and tenancy, agricultural credit, problems connected with the

marketing of farm products and the social and political side of rural life.

This work has been carried on since February 1.

2. Social and Economic Survey of a Rural Township in Southern Minnesota.—The aim is to take an inventory of the social and economic conditions of a rural township with a view to ascertaining household standards, the personal elements, conditions of work and recreation, facilities for marketing and communication, the extent of organization, and the general status of schools and churches.

This project was started June 1 with G. P. Warber as field agent. Mr. Warber spent the three summer months in a rural township, visiting each of the farm homes. A report on the work of this survey is being prepared.

3. Methods and Agencies of Egg-Marketing.—This study was started as a separate project on July 1, and will deal with the function and workings of various agencies involved in egg-marketing, with special reference to conditions in Minnesota.

*Outlines Prepared.*—In addition to the above, the Bureau has prepared an outline of the relations of the Department of Agriculture of the University of Minnesota to the development of the State aside from purely educational work and a summary of state organizations of agriculture and their relations to agricultural colleges and experiment stations.

## DIVISION OF AGRICULTURAL EXTENSION

During the past year fourteen different people have been used as itinerant lecturers. Ten of these have been employed full time, one, half time, and three, quarter time. This is in addition to the office and editorial work.

During the year sixty-one Short Courses were held, thirty-five Agricultural Short Courses and twenty-six Domestic Science Short Courses. At these courses there was an attendance of 25,800, counting the total attendance at all sessions.

During the season a number of special instructors were employed for from one to four weeks each to teach agriculture and home economics in the county training schools. Agriculture was taught at about twenty-four of these schools and home economics at twenty. The total number of teachers reached in this way was 18,697.

One thousand and fifty special meetings were held, with a total attendance of 84,890. This includes farmers' club meetings, county

fairs, special farmers' meetings, school officers' and teachers' meetings, and rural school meetings.

Two special trains were run, sixty-one stops were made, and 17,970 people reached.

Three men devoted practically their entire time to demonstration farm work, supervising twenty farms and visiting each farm at least twice each month. The supervision of the entire farm business is in the hands of these men in co-operation with the farm owners. At the demonstration farm at Pipestone, a special public demonstration in stock judging and management was given and at Osakis a public demonstration in the spraying of mustard was held.

*Industrial Contests.*—The Industrial Contest has been continued throughout the year and enlarged. Two men have devoted a large part of the year to this work. In addition to the regular State contest—in the production of corn, grain, vegetables, and in sewing and baking, in which from ten to fifteen thousand boys and girls have taken part—an Acre Yield Corn Contest has been conducted with about thirteen hundred competitors scattered throughout the State. In co-operation with the St. Paul Pioneer Press-Dispatch an Acre Yield Potato Contest has been conducted in nine counties, with about one thousand boys and girls taking part. In co-operation with the Minneapolis Tribune a girls' Tomato-Growing Contest has been conducted in twenty-three communities, and eleven hundred girls have taken part in this work.

One important addition to the Industrial Contest work has been the addition of booklet work on which prizes are offered for the best booklets prepared on fifteen or twenty selected agricultural topics. The preparation of these booklets requires considerable work on the part of each contestant, and in several counties hundreds of these booklets have been made up. It has proved to be one of the most satisfactory means of introducing the study of agriculture and home economics in the rural schools.

*Warm Lunches Provided.*—During the year one of the ladies in the Extension work inaugurated a plan to provide warm lunches for the boys and girls attending rural schools. The plan has been adopted by schools in several counties with most gratifying results. Several of the schools have been equipped with gas stoves and dishes, which has enabled them to serve all kinds of soups and furnish warm drinks for the pupils. Doing these things in the schoolhouse has opened up an opportunity to give more or less simple instruction in domestic science. Out of twenty or more teachers that have tried this plan in Douglas County all report very satisfactory results. In one school an entertainment was given, funds raised and a fireless cooker purchased. In this school soups, meats, and vegetables are prepared.

In the fall of 1911 demonstration tents sent to fifteen county fairs with educational exhibits were very much appreciated by farmers and fair boards. Judges have been supplied to most county fairs in the State. These county fairs are coming to be more and more educational each year, and in many places facilities are provided so that judges may explain the reasons for placing the exhibits, and thus make the fair more educational and interesting.

*Bulletins Distributed.*—During the year twenty-four numbers of University Farm Press News were published and distributed to the papers in Minnesota and adjoining states. Thirty-five hundred were published each issue. The following monthly extension bulletins were published as numbers of the Minnesota Farmers' Library:

- No. 19. Domestic Science in Rural Schools, Mary L. Bull
- No. 20. Soil Tillage, O. M. Olson
- No. 21. The Care and Management of Poultry, C. E. Brown
- No. 22. Establishing an Orchard, K. A. Kirkpatrick
- No. 23. Some Common Insects and Their Control, F. L. Washburn
- No. 24. Seed Testing, W. L. Oswald
- No. 25. Annual Pasture, Soiling and Hay Crops, Andrew Boss
- No. 26. Seed Grain, Andrew Boss and C. P. Bull
- No. 27. Flax-Growing, C. P. Bull
- No. 28. Tuberculosis, C. Easton and C. R. Barns
- No. 29. The Keeping of Dairy Cow Records, A. J. McGuire
- No. 30. Marketing Eggs from the Farm, N. E. Chapman

The mailing list for Extension Bulletins has grown to about 42,000.

During each of the nine school months, a four-page leaflet called "Rural School Agriculture" has been mailed to each of the rural school teachers in the State. Ten thousand copies were published each month.

## WEST CENTRAL EXPERIMENT STATION MORRIS

As yet no plans have been completed for Experiment Station work at Morris. The work now being carried on is designed chiefly to get the farm in shape for future operations. So far as we are at present able to determine it will be divided into three portions to be devoted to (1) farm management, (2) plat work, and (3) horticultural work.

A hundred and twenty acres have been laid out for a five-year rotation with a permanent night pasture. This rotation has been followed



for two years and yield data will be available this fall for both years. In connection with this we are handling a herd of a dozen common cows. This herd is headed by a registered Guernsey sire and the increase now includes seven half-blood Guernsey heifers. Records for the two years for this herd will also be available some time this fall.

About twenty acres near the campus is being prepared for plat experimental work. This year a number of grain variety tests have been conducted, but threshing has not yet been done. Several corn plat experiments have been conducted with a view to developing a corn better suited to our region.

An alfalfa experiment is also being carried on under direction of the college. Data for this will also be ready this fall. So far Minnesota Grimm has proved hardiest with Montana second in the scale. Kansas and Turkestan seeds have not proved hardy.

A portion of the farm (amount not yet determined) will be devoted to fruits, trees, and vegetables. This year several thousand conifers, golden willows, shrubs and small fruits have been set out. A few apple trees have also been planted.

The breeds kept in the poultry department have been such as would show the different types, viz.: meat breeds, this year, will be mated for "performance" characteristics. Work has just been started, too, in fattening birds. A finishing "battery" has been constructed and data are being collected to show the percentage of increase in weight due to different systems of feeding. Specimen eggs to show undesirable characteristics in eggs for hatching are being collected, blown and mounted, as well as typical eggs from the various breeds. All data gathered are being tabulated with the view of arranging a practical system of accounts for the poultryman. In addition work has been done in preserving eggs in water glass, studying the growth of the embryo in the egg, and candling and grading before all classes.

Five brood sows were purchased last year and now this department has about seventy hogs. No especial plans have yet been developed for the work.

## NORTH CENTRAL EXPERIMENT STATION GRAND RAPIDS

The work of the Station during the past year has been largely a continuation of the work of the past seven years, viz., the working out of a system of practical farming for the timbered section of Northern Minnesota, and the introduction of this system among the farmers.

The growing of field crops has resulted in a three-year rotation, which from present indications seems the most profitable for the small farms of this section of the State. This rotation is: grain followed by clover, clover followed by a cultivated crop, potatoes, corn, or field roots. After the cultivated crop the fields are again seeded to grain. All the small grains are grown successfully but oats give the most profitable returns. Field peas yield well on clay soil but they are not generally successful on sandy soil. Among forage crops, corn as fodder gives a greater yield per acre than millet or any of the forage grasses that are extensively advertised. Potatoes have proved the most profitable crop to grow for market. Manure seems to give the best results when applied as a top dressing on the fields seeded to clover.

In the test of varieties of corn for grain, Minnesota No. 23 matures the earliest, with Northwestern Dent a close second, the latter being better for fodder. The Carman No. 1 potato has been grown as the main field crop on the Experiment Farm for eight years and no other variety has excelled it. Among the oats no variety has been found superior to Improved Ligowo, which has been grown for a number of years on the Experiment Farm. Manshury has given the largest barley yields. Beardless and hull-less varieties have not been satisfactory in yield. Speltz has not been equal to barley in yield.

A special study is made of the profits in dairying under a practical system of farming, of the improvement made through using a registered dairy sire on common stock, of the difference in production in individual animals and in the most economical feeds. The dairy herd at the present time consists of 106 animals, eighty-nine of which are females. Large Improved Yorkshire hogs are raised in connection with the dairy to utilize the skim milk.

As mentioned in the 1911 report, the Poultry Department has been enlarged and is now located on a separate part of the farm. It is being run on a financial basis, with a poultryman in charge. Barred Plymouth Rocks and Single Comb White Leghorns are the breeds kept. The capacity of this department will be from eight hundred to one thousand hens.

The North Central Experiment Station conducted as much extension work as was possible during the past year, both by farmers' meetings and correspondence. Special assistance was given to co-operative work and to the distribution of pure seed.

NORTHWEST EXPERIMENT FARM  
CROOKSTON

*Farm Experiments.*—The farm proper consists of five fields of about 50 acres each, in five-year rotation, and seven fields of 30 acres each in seven-year rotation. It is so managed that we expect to obtain data along a number of different lines.

*Drainage.*—We are keeping careful records of the results obtained on drained and undrained fields, but the precipitation has been so small during the last three seasons that no marked differences have been observed. The reports of rainfall during the fiscal year show that there was a total precipitation of 18.4 inches or about one inch less than the year before, two inches more than two years ago, and about eight inches below the average for this section of Minnesota. Under these conditions we have noted no special results from the tile and open surface drainage installed here in 1909.

*Farm Management.*—*Crop Rotation.*—The two series of major farm crop rotations begun in 1911 were continued. At this writing the crop records are not available because all the grain is not yet harvested. In a general way it may be stated that the fields are yielding better returns than at any time before and that we are already seeing the benefits from having a scientific rotation.

*Soil Fertility.*—Farmyard manure is being used on the fields of these major crop rotations. We are trying several methods of applying manure. More stock is needed but cannot be provided until there is more room for wintering it.

A complete soil survey of the farm should be made at once in order that we may have better information as to the needs of the various types of soil on this farm.

*Corn, Clover and Timothy.*—Seed corn matured last fall and all that was fit was saved and disposed of. There was a fair catch of clover and timothy. The grass seed sown this spring seems to have caught excellently, insuring that the rotation plans may be followed, and giving a plentiful supply of hay.

*Pure Seed Work.*—Nearly \$3,000 worth of pure seed was sold this spring from seed raised on the larger fields. There was a demand for eight or ten times that amount which we could not fill. Because of lack of storage facilities, we were compelled to sell one thousand bushels of grain which would have been worth much more as seed grain. With the extensive variety test work that is now being done, the large farm fields will be enabled to supply a larger quantity than ever before of pedigreed seed adapted to this part of Minnesota. The work of encouraging the growing of pure seed is an especially impor-

grasses are under test. In a two-acre flax fiber experiment conducted in co-operation with the United States Department of Agriculture, we are testing a Russian fiber type of flax that has been grown in this country for five years, and seed of a domestic fiber flax variety grown in a crop of 1911. Winter wheat sown in barley stubble in 1911 winterkilled, but that sown between rows of standing corn on an adjoining plat gave a fine stand and promises a yield of over 40 bushels per acre.

Other work in progress includes corn breeding work with Minnesota Number 13 and Minnesota Number 23. The use of the subsurface packer and the subsoil plow, subsoiling with dynamite, sowing wheat at rates ranging from 45 to 90 pounds per acre, and oats at from one to three bushels per acre, and thirteen acres devoted to Minnesota Number 23 corn for seed, and field trials of winter wheat and rye should also be mentioned. A test of methods of sowing grasses includes a demonstration plat of 0.25 acres, and grass on corn stubble and on potato ground without plowing.

*Horticultural Projects.*—In the vegetable garden we are conducting tests of two varieties each of cucumber, cabbage, beans, cauliflower, squash and pie pumpkins; three each of parsnips, beets, peas and sweet corn; four varieties of carrots; seven of tomatoes; and one each of lettuce, rutabagas and turnips. A home canning outfit has been secured and trials have been conducted to determine the feasibility of its use.

Seven varieties of potatoes are being tested and seed tests include the use of cellar selected, hill selected, common run, untreated scabby seed, scabby seed treated with formalin, and rose tips or run out seed. Seed ends and stem ends with eyes are also being used. In larger fields, untreated and formalin treated seed of Carman and the Early Ohio are being used. Each of these varieties is also being sprayed three times in a spraving test while other varieties are sprayed only twice, with a 5-5-50 Bordeaux mixture test.

*Nursery Work.*—Grafts have been made of the Duchess, Okabena, Patten's Greening, Hibernial, and Whitney Number 20, as they are regarded the hardier varieties. Cuttings were made of such ordinary shrubs and varieties as bush honeysuckle and Virginia Creeper. Four thousand willow cuttings were made and set, and we collected seeds of green ash, box elder, Siberian pea tree, buffalo berry and buckthorn. Six apple varieties, three varieties each of grapes, crab apples and plums, and two of cherries were planted for testing, as were gooseberries, raspberries, grapes, strawberries, conifers, and some experimental lawn grasses.

*Live Stock.*—Improved Yorkshire and Duroc-Jersey hogs have been kept for sale, and we are establishing a flock of pure-bred Shrop-

shire sheep in order to supply breeding stock. A team of registered Percheron mares have been purchased, and a driving team and a team of coach horses for light hauling are also needed. These animals should be as good as possible in order that the young stock may find a ready market. The Station has two Herefords and two Polled Angus cattle, but needs a larger number in order to supply beef for the dining hall, to supply specimens for school judging work, and to supply manure for building up the farm fields. The Holstein project is working out satisfactorily and the Shorthorn cows are making fair milk records.

The poultry work has dealt especially with Barred Plymouth Rocks and S. C. White Leghorns. Toulouse and African geese, and Pekin ducks are also raised. A great deal of breeding stock has been distributed and the following lines of experimental work have been taken up: wet and dry mash feeding, a comparison of different solutions of water glass and a commercial powder as egg preservatives, feeding little chicks, a comparison of artificial and natural hatching and rearing, and a comparison of different types of colony houses.

In summing up the work of the Northwest Experiment Farm, there seems to be a special need for continuation of work with pure seed, and an enlargement of that with beef cattle, and the institution of several new experiments relating to agricultural practices in this part of the State, including experiments in the use of commercial fertilizers of various kinds.

Respectfully submitted,

A. F. WOODS,  
*Director*